



Golder Associates Inc.
18300 NE Union Hill Road, Suite 200
Redmond, Washington 98052
Telephone: (425) 883 0777
Fax: (425) 882 5498



DRAFT

**SUPPORT PLANS FOR THE
ENGINEERING EVALUATION/COST ANALYSIS
WORK PLAN FOR THE
AVERY LANDING SITE
AVERY, IDAHO**

Submitted to:

Potlatch Land and Lumber, LLC

Submitted by:

*Golder Associates Inc.
18300 NE Union Hill Road, Suite 200
Redmond, Washington 98052*

May 13, 2009

073-93312-02.002

ATTACHMENT A

TREATABILITY STUDY WORK PLAN



Golder Associates Inc.

18300 NE Union Hill Road, Suite 200
Redmond, Washington 98052-3333
Telephone (425) 883-0777
Fax (425) 882-5498
www.golder.com



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DRAFT

Douglas J. Morell, Ph.D., L.H.G.
Principal

DRAFT

Lee K. Holder, P.E.
Associate Engineer

May 13, 2009

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1.0 INTRODUCTION

This document is the Treatability Study Workplan for the Avery Landing Site (the Site), prepared by Golder Associates Inc. (Golder) on behalf of Potlatch Land and Lumber LLC (Potlatch).

1.1 Background

The Site is located along State Highway 50 about 0.75 mile west of the town of Avery, Idaho (Figures 1 and 2). The Site was originally developed as a railroad roundhouse, maintenance, repair, and fueling depot. There is little remaining at the Site to indicate its previous use. Presently the Site is relatively flat ground with gravel and sparse vegetative growth. The ground is composed mainly of fill, presumably to create a larger flat area for the railroad operations.

Potlatch entered into Administrative Order on Consent (AOC) No 10-2008-0135 with the U.S. Environmental Protection Agency (EPA) to complete an Engineering Evaluation / Cost Analysis (EE/CA) for the Site. In support of the EE/CA, a treatability study will be performed to provide data on potential treatment options.

The following COPCs have been identified for Site soils:

- Diesel and heavy oil
- Naphthalenes
- PAHs (including carcinogenic PAHs)

Potential treatment technologies include:

- In-situ biological treatment
- In-situ chemical treatment
- Soil washing
- Land treatment (landfarming)
- Thermal desorption.

1.2 Purpose and Scope

The purpose of this workplan is to define and describe the work to be performed to complete the treatability study for the Site in support of the EE/CA.

In-situ biological and chemical treatment technologies will be considered in the EE/CA using a literature review and desktop evaluation. Because of the amount of LNAPL present, it is expected that no proven in-situ treatment technology (other than LNAPL removal) will be practical. Therefore, in-situ treatment is not included in this treatability study.

The scope of this treatability study will focus on size separation and soil washing. This treatment approach is believed to have the highest potential for practical application to the Site. Petroleum compounds typically concentrate in the finer soil fractions (smaller particle sizes). In addition, larger size particles (e.g., gravel and coarse sand) are typically easier to clean by soil washing than smaller

size particles because the larger-size particles have less sorption capacity and are usually simply coated on the surface. However, the extent to which these factors apply can vary considerably in different soils.

By separating clean and contaminated size fractions, size separation reduces the quantity of material requiring disposal or further treatment. Soil washing removes contaminants from soil, thereby eliminating or reducing the quantity of material requiring disposal or further treatment. Even when soil washing does not achieve cleanup levels, the contaminant reduction can reduce the difficulty and cost of further treatment. Thus, soil washing can function as stand-alone treatment, or as pretreatment in conjunction with another technology (e.g., land treatment or thermal desorption).

The objective of the soil washing treatability study will be to determine the residual TPH concentrations in various size fractions after size separation and soil washing. These results will indicate which size fractions require no further treatment after soil washing, and which need either further treatment or disposal. The percentages of the various size fractions will be determined during the study.

The analytical results from the various soil fractions and residuals resulting from soil washing will be compared to cleanup goals. Those fractions and residuals meeting cleanup goals will not require disposal or further treatment.

Those fractions and residuals not meeting cleanup goals will be evaluated for further treatment. First, the estimated costs of off-site landfill disposal, on-site thermal desorption, and on-site land treatment will be compared (assuming for the moment that both treatment technologies would be sufficiently effective). If this cost comparison indicates that on-site treatment warrants further consideration, then the soil fractions and residuals from soil washing that do not meet cleanup goals will be combined into a sample for further treatment testing. In this case, this treatability study work plan will be amended to define the additional treatment studies to be performed for land treatment and/or thermal desorption.

If land treatment is to be considered (based on the cost comparison), then a treatability test would be required to determine effectiveness. However, the specifics of such testing would vary with the nature of the materials to be treated, and is therefore not specified at this time.

Thermal desorption is generally effective on petroleum compounds. Based on analysis of samples obtained during this treatability study (TPH, TOC, moisture, particle size), an approximate cost estimate can be prepared for thermal treatment in the EE/CA. Because of this, it is not expected to be necessary to perform bench- or pilot-scale testing for evaluating alternatives. However, if it appears that thermal treatment will be included in the preferred remediation alternative, then additional treatability testing may be performed to demonstrate effectiveness and better define treatment costs before completing the evaluation of alternatives.

2.0 SOIL WASHING STUDY PLAN

Size separation and soil washing are addressed in an integrated manner in the study plan described in this section. It is anticipated that the bench-scale testing described herein will be performed by ART Engineering (Tampa, Florida) under the oversight of Golder. Laboratory analyses will be performed by Pace Analytical (Seattle, Washington) or other qualified laboratory.

2.1 Sample Collection

Bulk samples of the soils in the “smear zone” impacted by LNAPL (from approximately 12 to 14 feet below ground surface) will be obtained from 6 locations at the Site, as shown on Figure 2. The test pits will be located in areas where LNAPL has been found in wells during previous investigations. The test pits are spread throughout the eastern half of the Site in order to obtain aerial coverage across the portion of the Site where known LNAPL is present. If, after a test pit is excavated, no LNAPL smear zone is observed, the location of that test pit will be moved over several feet in an attempt to find a smear zone for sample collection. These samples will be obtained from test pits using an excavator. The bulk soil samples will only contain soil from the LNAPL smear zone (i.e. “clean” soil will not be collected for the bulk soil samples). The soil from the test pits will be placed on plastic sheets and mixed using the excavator bucket and/or shovels. Photographic documentation will be made of field conditions and the test pits during sampling.

Two 5-gallon buckets of soil from each test pit (total 60 gallons) will be shipped to ART Engineering in Tampa, Florida. Samples from each test pit will also be collected laboratory provided containers and submitted to Pace Analytical for laboratory analysis. These samples will be composited and labeled as discussed in Section 2.2. One 55-gallon drum of soil from each test pit will be retained on-Site for possible future use.

2.2 Sample Compositing

ART Engineering will prepare three composite samples from the 60 gallons of soil collected for the bench testing. Composite #1 will be from test pits TS-1 and TS-2, Composite #2 from TS-3 and TS-5, and Composite #3 from TS-4 and TS-6 (see Figure 2). These samples will represent the range of concentrations in soil that might be treated. Performing three washing tests (one for each composite) will provide an indication of variability in both the soils and also the washing process. Bench-Scale Testing. Figure 3 shows a flow diagram of the soil washing treatability study. This approach is designed to simulate the steps in the soil washing process. Each of the composite samples will be processed separately as indicated in this figure.

2.2.1 Soil Screening at 1/2" and Coarse Gravel Washing

Each of the three composite samples will be dry-screened at 1/2". The coarse gravel fraction will be washed using water at room temperature. The washed gravel will be Sample “A”.

2.2.2 Soil Washing

The soil fraction less than 1/2" (Sample “B”) will be passed dry through a 10-mesh screen to produce Sample “C”. This same soil fraction (Sample “B”) will also be processed through wet screening at 10 mesh and hydraulic separation at approximately 200 mesh to simulate the full scale soil washing process. The fines fraction and wash water will be flocculated and dewatered into the simulated filter cake. The following products will be generated by this hydraulic separation:

- Washed gravel 10 mesh to ½" (Sample "D")
- Dewatered fines fraction (Sample "E")
- Sand after hydraulic separation (Sample "F")
- Wash water from the hydraulic separation and dewatering (Sample "WW").

Three washing tests (Samples "WS-1", "WS-2", and "WS-3") will be performed on the sand after hydraulic separation. The objective of the additional washing tests will be to determine the lowest possible hydrocarbon level in the sand through use of surfactants and/or elevated temperatures. These tests will be performed sequentially, and subsequent tests (with more aggressive/expensive treatment) may not be performed if sufficient cleanup is achieved in earlier test.

2.3 Laboratory Analyses

Table 1 shows the plan for chemical analysis. Refer to Figure 3 for sample designations.

Composite samples #1, #2, and #3 that are submitted directly to Pace Analytical represent the concentrations of COCs in the smear zone before treatment. These samples will be analyzed for COCs, particle size distribution, and moisture content. These results will be used to compare to the treated sample results.

Laboratory analyses cannot be performed directly on gravel-size particles. Therefore, gravel samples "A" and "B" will be crushed to 95% passing a 10 mesh screen before sending to the laboratory for chemical analysis along with the other samples. Sample "C" is soil passing a 10 mesh screen, and therefore does not require crushing.

In addition, a particle size distribution analysis using wet screening will be performed by ART Engineering on Sample "B" (the soil fraction less than ½"). The results will be mathematically corrected for amount of coarse gravel greater than 1/2" that was removed by the initial screening.

It is difficult to obtain meaningful direct analytical results (mg/kg) on soils with large particle sizes. Sample photographs before and after washing will document the effectiveness of washing the Site gravel, as well as written documentation summarizing visual observation of the wash results. In addition, the Synthetic Precipitation Leaching Procedure (SPLP, EPA Method 1312) will be run on the washed gravel samples and analyzed for TPH.

3.0 SCHEDULE AND REPORTING

It is expected that this workplan will be approved no later than mid-May 2009. If this is the case, then sample collection for this treatability study can start performed in the late spring or early summer of 2009.

The soil washing study is expected to take approximately four weeks (excluding analytical time) from the time samples are obtained, plus an additional three weeks for laboratory analysis. The Treatability Study Report will be prepared within approximately one month of receipt of the analytical results.

A report will be prepared on completion of the testing, documenting the study methodology and results. Evaluation of the results (including comparison to appropriate cleanup levels) will be performed in the EE/CA.

TABLE

TABLE 1
Treatability Study Analytical Plan
Avery Landing Site

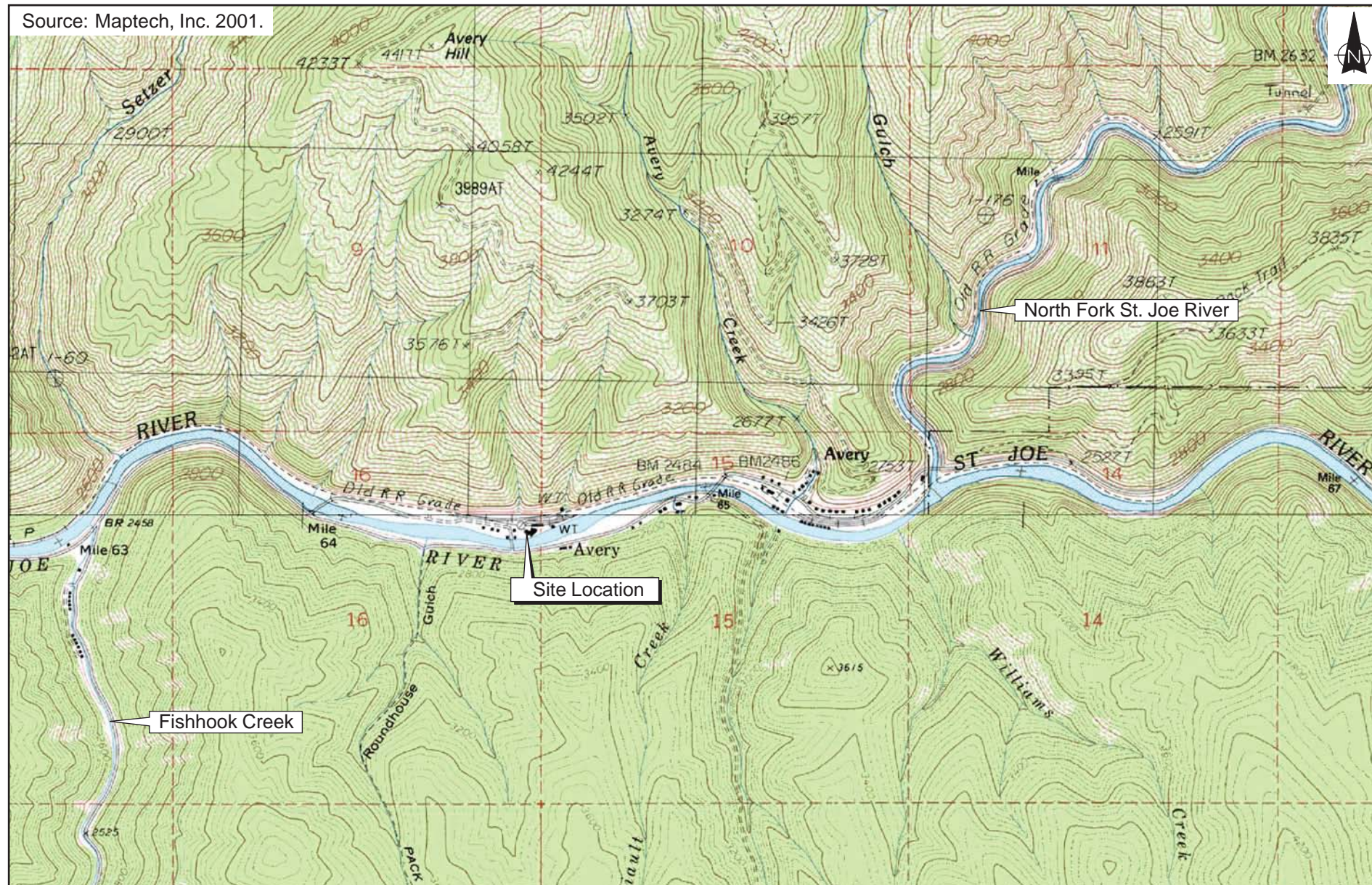
Sample	Sample ID	Particle Size Analysis	Moisture (% by weight)	TPH-diesel extended	Soil TOC	TPH-diesel on SPLP leachate	PAHs by GC/MS	PCBs	COPC Metals
Composites #1, #2, and #3		X	X	X			X		
Washed gravel	Sample "A"	X	X			X	X	Note 2	
Soil fraction minus 1/2" (crushed)	Sample "B"	X	X	X	Note 3		X	X	
Soil fraction minus 10 mesh (crushed)	Sample "C"	X	X	X	Note 3			Note 2	
Washed fine gravel (+10 mesh - 1/2", crushed)	Sample "D"	X	X	X	Note 3			Note 2	
Fines filter cake	Sample "E"	X	X	X	Note 3		X	Note 2	
Sand after hydraulic separation	Sample "F"	X	X	X	Note 3		X	Note 2	
Wash water from hydraulic separation	Sample "WW"			X			X	Note 2	X
Washed sand - Test 1	Sample "WS-1"	X	X	X	Note 3		X (see Note 4)	Notes 2 & 4	
Washed sand - Test 2	Sample "WS-2"	X	X	X	Note 3				
Washed sand - Test 3	Sample "WS-3"	X	X	X	Note 3				

NOTES:

1. Refer to Soil Washing Treatability Study Flow Diagram for sample designations.
2. PCB analysis if and only if PCBs concentration exceeds cleanup level in Sample B.
3. Samples not meeting cleanup goals based on TPH-diesel will be analyzed for Soil TOC.
4. One washed sand sample will be selected for PAH and PCB analysis based on TPH results.

FIGURES

Source: Maptech, Inc. 2001.



Source: Ecology and Environment, Inc., 2007

FIGURE 1
SITE VICINITY MAP
TREATABILITY STUDY WORK PLAN AVERY LANDING SITE/WA



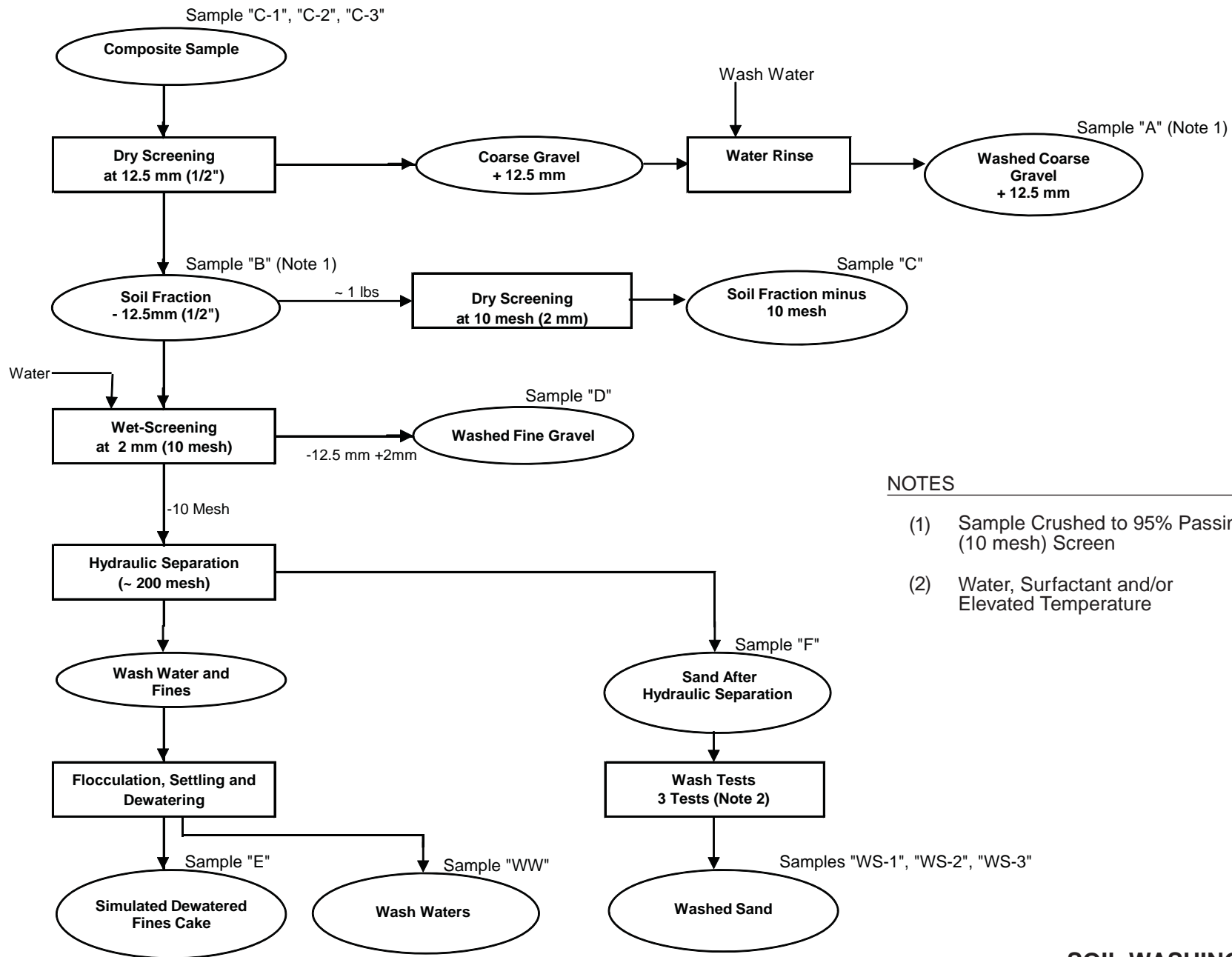
LEGEND

- | | |
|--|--|
| <p>--- Property Line
& Section 16-15 Division Line</p> <p>[---] Site Boundary</p> <p>⊕ EPA Monitoring Well</p> <p>● EPA Soil Boring</p> <p>● Monitoring Well</p> | <p>⊕ Surface Water Sample Location</p> <p>● Domestic Well</p> <p>⊕ Proposed EE/CA Monitoring Well</p> <p>▲ River Sediment and Floating LNAPL
and Surface Water Sampling Location</p> <p>■ Treatability Study Test Pits</p> |
|--|--|

0 140
APPROXIMATE
SCALE IN FEET



FIGURE 2
TREATABILITY STUDY SAMPLING LOCATIONS
TREATABILITY STUDY WORK PLAN AVERY LANDING SITE/WA



NOTES

- (1) Sample Crushed to 95% Passing 2 mm (10 mesh) Screen
- (2) Water, Surfactant and/or Elevated Temperature

Modification of Figure Provided by ART Engineering, LLC

0739331202002fig03_R1.ai | Mod: 04/30/09 | AMP

FIGURE 3
SOIL WASHING TREATABILITY
STUDY FLOW DIAGRAM
POTLATCH/AVERY LANDINGEE/CAPLANS/ID

ATTACHMENT B

FIELD SAMPLING AND ANALYSIS PROJECT PLAN (SAP)



Golder Associates Inc.
18300 NE Union Hill Road, Suite 200
Redmond, Washington 98052
Telephone: (425) 883 0777
Fax: (425) 882 5498



DRAFT

ATTACHMENT B

**DRAFT FIELD SAMPLING AND ANALYSIS PLAN
FOR THE
ENGINEERING EVALUATION/COST ANALYSIS WORK PLAN
AVERY LANDING SITE
AVERY, IDAHO**

Submitted to:

*Mr. Terry Cundy
Potlatch Land and Lumber, LLC*

Submitted by:

*Golder Associates Inc.
Redmond, Washington*

DRAFT

Douglas J. Morell, Ph.D., L.H.G.
Principal/Project Manager

DRAFT

Kirsi S. Longley
Project Environmental Scientist

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Appendix A	Quality Assurance Project Plan (QAPP)
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LIST OF ACRONYMS AND ABBREVIATIONS

amsl	above mean sea level
AOC	Administrative Order on Consent
bgs	below grade surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	cubic feet per second
COPCs	contaminants of potential concern
DI	Deionized
EPA	U.S. Environmental Protection Agency
FWS	U.S. Fish and Wildlife Service
Golder	Golder Associates Inc.
HASP	Health and Safety Plan
IDAPA	Idaho Administrative Procedures Act
IDEQ	Idaho Department of Environmental Quality
IDW	investigative derived waste
IDWR	Idaho Department of Water Resources
LNAPL	light, non-aqueous phase liquids
MCL	maximum contaminant level
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
Milwaukee Railroad	Chicago, Milwaukee, St. Paul and Pacific Railroad Company
µg/L	microgram per liter
NTU	nephelometric turbidity units
PAHs	polynucleated aromatic hydrocarbons
Potlatch	Potlatch Forest Corporation and Potlatch Corporation
PCBs	polychlorinated biphenyls
PQL	Practical Quantification Limit
QA	quality assurance
QP	quality procedures
QAPP	Quality Assurance Project Plan
RAO	removal action objectives
ROW	right-of-way
SAP	Field Sampling Analysis Plan
SDS	Sample Data Sheets
Site	Avery Landing Site, Avery Idaho
TP	technical procedures
VOC	volatile organic compounds
Work Plan	Engineering Evaluation/Cost Analysis Work Plan for the Avery Site

1.0 INTRODUCTION

Potlatch Land and Lumber, LLC (Potlatch) has entered into an Administrative Order on Consent (AOC) No 10-2008-0135 with the U.S. Environmental Protection Agency (EPA) to complete an engineering evaluation/cost analysis (EE/CA) for the Avery Landing Site (Site). The EE/CA will provide sufficient information on the source, nature, and extent of contamination, any human health and ecological risks presented by the Site, and recommended removal action alternatives appropriate for addressing the removal action objectives. This document is the Field Sampling and Analysis Plan (SAP) for conducting the EE/CA at the Site and is Attachment B of the EE/CA Work Plan. The SAP is supported by the Quality Assurance Project Plan (QAPP), provided as Appendix A to this report. The SAP describes or references the field procedures that will be used for the collection of data. Field procedures that are routinely used by Golder Associates Inc. (Golder) are standardized as Technical Procedures (TP) or Quality Procedures (QP) and will be provided if requested.

The statement of purpose and EE/CA objectives are outlined in Section 1 of the EE/CA Work Plan. The Site historical and background information are summarized in Section 2 and the physical setting in Section 3 of that document. This SAP provides guidance for the field tasks that will support the EE/CA scope of work presented in Section 5 of the Work Plan. The activities addressed in the scope of work in the Work Plan have been organized into field tasks to be conducted under this SAP.

The overall approach for the EE/CA is to assess the nature and extent of the contamination at the Site and to evaluate a limited number of removal action alternatives appropriate for addressing the contamination that has impacted soil, groundwater, and surface water. The EE/CA removal action evaluation will support the recommendation of a Non-Time Critical Removal Action that meets Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requirements. The EE/CA focuses on the protection of human health and the environment considering the direct exposure to shallow soils, protection of groundwater supplies, and protection of the St. Joe River.

1.1 Site Location

The Site is located along State Highway 50 about 0.75 miles west of the town of Avery, Idaho (Figure SAP-1). The Site boundary is shown on Figure SAP-2 and extends along the St. Joe River about 0.5 miles. The Site property is within the NW quarter of Section 15, Township 45North, Range 5 East and the NE quarter section of Section 16, Township 45 North, Range 5 East, Willamette Meridian. The approximate latitude is 47° 13' 57" North and longitude is 11° 43' 40" West.

Presently, there are four properties located on the Site: Highway 50 Property (owned by the Federal Highway Administration and the U.S. Forest Service); the Bencik property; the Potlatch property; and the State of Idaho property (stream bed and banks of the St. Joe River as well as the Site groundwater). Several residents live on-Site year-round, and several more reside on the property seasonally. A domestic groundwater supply well is in the western portion of the Potlatch property for use by the residents and visitors. The eastern portion of the Potlatch property is vacant with numerous monitoring wells and piezometers that are used for monitoring groundwater. Access to the Site is unrestricted. The immediate area around the Site is residential and recreational. The St. Joe River is adjacent to the Site.

1.2 Background

The Site was used as a Chicago Milwaukee St. Paul Railroad (herein referred to as a Milwaukee Railroad) maintenance and fueling station from 1907 to 1977. In 1980, Potlatch acquired ownership

of a portion of the Site and utilized it as a log landing and log storage area through the 1980s. Portions of the property were leased to third parties for a variety of uses such as log storage, material storage, parking, cabin sites and trailer sites (a number of which are still in effect). Historically, the Milwaukee Railroad had stored and handled petroleum products and hazardous substances on the Site.

As indicated in Section 2 of the Work Plan, investigations have been conducted onsite since the late 1980s. Removal actions have included impacted soil excavation, floating product capture trenches, and the installation of an impermeable vertical wall along the St. Joe River. In 1994, three separate floating product capture trenches were installed to intercept groundwater having floating petroleum products called Light Non-Aqueous Phase Liquids (LNAPLs). LNAPL was removed from the trenches using skimming-type pumps. The system operated from 1994 to 2000 and recovered approximately 1,290 gallons of oil. Golder understands that portions of the trenches became dry and failed to capture all floating LNAPLs, as witnessed by continued floating LNAPL discharges along river bank seeps. In 2000, an impermeable vertical wall was installed along the St. Joe River to prevent floating LNAPL from migrating to the river. The LNAPL was to be removed from capture wells located up-gradient of the barrier. This removal system appears to have worked for a number of years until seeps containing LNAPL oil were observed during river low flows in the fall of 2005. As a result, oil absorbent booms were placed in the river around the seeps. This SAP only addresses work to be completed under the tasks identified in the EE/CA Work Plan.

2.0 FIELD INVESTIGATION APPROACH AND TASK ASSIGNMENTS

2.1 Approach

The Site encompasses about 10 acres. The uses of the site include Highway 50 right-of-way, stream banks of the St. Joe River, and residences. A domestic water supply well is also on the property. All adjacent and surrounding properties are considered off-site areas in this SAP. A map of the location of the Site is illustrated in Figure SAP-1. Figure SAP-2 is a detailed project layout map of the Site.

In Section 4 of the Work Plan, information on the Site conditions and conceptual model is provided. The major issues and approach for the EE/CA are also presented Section 4 of the Work Plan. The SAP tasks that will generate data have been identified for the Site and are outlined below:

- **Phase I – Subsurface Soil Investigation** (TBD)
 - Task 1: Additional Soil Sampling
 - Task 2: Treatability Study Soil Sampling
- **Phase II – Groundwater Investigation** (TBD)
 - Task 1: Additional Monitoring Well Installation
 - Task 2: Groundwater Sampling
 - Task 3: Groundwater hydraulic Gradient Investigation
 - Task 4: Groundwater Pump Test
- **Phase II – Near Shore Investigation** (TBD)
 - Task 1: Near Shore Floating LNAPL Sampling
 - Task 2: Near Shore Surface Water Sampling
 - Task 3: Near Shore Sediment Sampling
- **EE/CA Evaluation & Reporting** (Project Team)

To the extent practicable, Treatability Study soil sampling will take place during SAP soil sampling activities.

2.2 Task Assignments

The lead field personnel responsible for each task are identified in the above list of field tasks. Section 3 of this SAP describes each EE/CA field investigation task, identifies the media and sampling locations, provides the field procedures and defines the physical and chemical analyses that will be performed during this EE/CA. Each field leader will be responsible for the work being conducted in accordance with the Treatability Study Work Plan (Attachment A of the EE/CA Work Plan), this SAP (Attachment B of the EE/CA Work Plan), the QAPP (Appendix A of this SAP), the HASP (Attachment C of the EE/CA Work Plan), the Biological Assessment Work Plan (Attachment B of the EE/CA Work Plan), and the Cultural Resource Work Plan (Attachment E of the EE/CA Work Plan).

3.0 FIELD INVESTIGATION TASKS

This section describes the EE/CA field investigation tasks that will be conducted. The media and sampling locations are identified along with the procedures and nomenclature that will be used for sample acquisition and documentation. The QAPP (Appendix B of the SAP) and Golder Technical Procedures or the referenced sampling procedures shall be used in conjunction with this SAP for implementation of the EE/CA field tasks. Before any intrusive work is conducted within the Site boundary, the Site owners will be notified of the work schedule at least one week prior to mobilization. The location of the intrusive boring and the access route to each sampling location for drilling/sampling equipment must also be approved by Potlatch prior to mobilization.

3.1 Phase I – Subsurface Soil Investigation

3.1.1 Task 1 – Soil Sampling

In addition to prior sampling done in the area of the boiler room and machine shop, Golder will collect subsurface soil samples from the western portion of the Site (west of current residential buildings) and from the area in the vicinity of the former 500,000 gallon fuel oil tank. Bulk soil samples from the “smear zone” within the known LNAPL Plume area will be obtained for testing in the Treatability Study (Attachment A of the EE/CA Work Plan). The soil sample data will provide information on potential releases of petroleum products and hazardous materials on the western portion of the Site and to determine the northern and eastern extent of the contamination in the vicinity of the old fuel oil tank that is believed to be the source of released oil.

Seven test pits will be excavated at locations shown on Figure SAP-3 in the western portion of the Site. Three of the test pits (TP-5, TP-6, and TP-7) will be located along former railroad spurs while the remaining four test pits (TP-1 through TP-4) will be located randomly through the rest of the western half of the Site in order to achieve representative aerial coverage of the Site. The test pit soil samples will be obtained using an excavator until groundwater is observed, which is expected to occur at a depth of approximately 10 to 12 feet below ground surface (bgs). If the excavator is not able to reach groundwater (at approximately 10 to 12 feet bgs) because the substrate encountered is too rocky, a hollow-stem auger (HAS) drill rig will be used to collect the soil samples. The type of drill rig that is used will also be limited by what is available through local drilling companies.

Five boreholes will be drilled using a hollow-stem auger in order to collect soil samples in the vicinity of the former fuel oil tank located adjacent north of Highway 50, as shown on Figure SAP-3. These samples are to investigate a portion of the Site that is a potential source location that has not been previously investigated. Boreholes will be used to obtain soil samples in the vicinity of Highway 50, because boreholes will pose less risk to the integrity of the highway and boreholes provide the ability to obtain samples beneath the highway without having to close a portion of the road to traffic. Two of the HAS boreholes (BA-2 and BA-3) will be drilled at an angle to be able to inspect soils beneath Highway 50. The remaining three HAS boreholes (BA-1, BA-4, and BA-5) will be drilled vertically. During drilling, soil samples will be obtained at five-foot intervals and at the interface of the water table.

Six additional test pits will be excavated in the vicinity of the former railroad facility on the eastern part of the Site as part of the Treatability Study. The approximate locations of the Treatability Study test pits are depicted on figure SAP-3 and are labeled TS-1 through TS-6. The test pits will be located in areas where LNAPL has been found in wells during previous investigations. The test pits are spread throughout the eastern half of the Site in order to obtain aerial coverage across the portion

of the Site where known LNAPL is present. The purpose of the Treatability Study test pits is to obtain bulk samples of soil from the LNAPL smear zones in order to identify the effectiveness of washing Site soils that are impacted by LNAPL. The bulk soil samples will only contain soil from the LNAPL smear zone (i.e. “clean” soil will not be collected for the bulk soil samples). If, after a test pit is excavated, no LNAPL smear zone is observed, the location of that test pit will be moved over several feet in an attempt to find a smear zone for sample collection. The soil samples will be placed in 55-gallon drums for shipment to the selected laboratory. The Treatability Study sampling activities are discussed further in the Treatability Study Work Plan located in Appendix A of the EE/CA Work Plan.

The test pit and drilling activities will be subject to protocols and procedures specified in the relevant Golder Technical Procedures referenced below. These technical procedures will be provided upon request.

- TP 1.2-5 “Drilling, Sampling, and Logging Soils”
- TP 1.2-18 “Sampling Surface Soil for Chemical Analysis”
- TP 1.2-6 “Field Identification of Soil”
- TP 1.2-23 “Chain of Custody”

The Golder sample forms to be completed with these technical procedures are contained within the technical procedures.

3.1.1.1 Preparation activities

Preparation activities for this task include the following:

- Preparing bid package and contracting for certified excavation and drilling contractors;
- Coordination with the chemical analytical laboratory;
- Mobilizing necessary field equipment and supplies;
- Obtain necessary drilling permits and START Cards from Idaho Department of Water Resources (IDWR) for drilling boreholes to obtain soil samples;
- Obtain necessary County and/or Federal permits for drilling within and/or adjacent to the Highway 50 right-of-way;
- Obtain access permission for the Benticik property; and
- Underground utility locating through public utility locate request and contracting with a private locator.

Before all intrusive subsurface investigation activities, the Potlatch Site Manager shall be notified and a utility locate request will be filed with local utility organizations. All utilities located by the Utility Locating Services will be confirmed as clear before beginning subsurface excavation and drilling activities.

3.1.1.2 Soil Sampling

Excavation and drilling will be done on the Site by an Idaho licensed contractor and under the continuous supervision of a Golder field representative. Proposed test pit and soil borehole locations

are presented in Figure SAP-3 and have been established in areas where investigative data is absent. At each test pit or borehole, soil samples will be collected from the surface, middle, and bottom depths. If soils are discolored, stained and appear impacted, a soil sample will be obtained representing the potentially impacted horizon as a substitute for the middle depth soil sample. If multiple horizons of impacted soil are observed, each horizon will be sampled in addition to the surface and bottom depths of the test pit or borehole. During drilling, soil samples will be obtained using a 2.5-inch or larger diameter drive tube fitted with a lined split-spoon sampler at every five-foot interval (starting at the surface) and at the interface of the water table. Soil samples will be logged and described in the field using the USCS classification and a Munsell soil color chart. Borehole soil will be transferred into new clean plastic wide mouth bottles, labeled, and archived for potential future analytical testing.

3.1.1.3 Selection of Soil Samples for Chemical Analyses

The test pit spoils or split-spoon samples will be inspected for indication of the presence of petroleum hydrocarbons based on field screening methods (i.e., visual signs, sheen testing, olfactory senses, and PID measurements). Soil selected for laboratory analysis will be placed in glass sample bottles that are appropriate for chemical analyses of the contaminants of potential concern (COPCs) as specified in the QAPP (see Appendix A). Table 4 of the QAPP lists the appropriate sample bottles for each analysis.

The Site COPCs and laboratory analytical methods that Test America Analytical Services are to use are as follows:

- Northwest Total Petroleum Hydrocarbons for diesel and extended range organics (NWTPH-Dx);
- EPA SW-846 methods for poly-aromatic hydrocarbon compounds (carcinogenic and non-carcinogenic) and naphthalene (EPA 8270C);
- EPA SW-846 methods for polychlorinated biphenyls (EPA 8082) on surface samples at each sampling location;

All obtained soil samples will be sent to Test America Analytical Services laboratory in Spokane, Washington.

In an effort to minimize analytical expense while maximizing the soil data collection efforts, Golder will request that all soil samples from test pit excavations GA-1 through GA-4 (or from borings if test pit excavation was not possible) be analyzed for diesel/heavy oils, polyaromatic hydrocarbons (PAHs) and naphthalene. Only the near surface soil samples from each test pit will additionally be analyzed for polychlorinated biphenyls (PCBs). Golder will have all surface soil samples and water table interface soil samples from each air-rotary borehole BH-1 through BH-5 (located adjacent to the former 500,00 gallon fuel oil tank) analyzed for diesel/heavy oils and PAHs. The surface soils sampled from each borehole will also be analyzed for PCBs. Additional vadose zone soil samples will only be analyzed for diesel/heavy oils and PAHs if the sample appears to be visually impacted by petroleum hydrocarbons.

The reference analytical methods and required laboratory PQLs are listed in the Table QAPP-4 of the QAPP (Appendix A of this Field Sampling and Analysis Plan).

3.1.1.4 Sample Nomenclature and Documentation

Documentation for sampling will include bottle labels, completion of Sample Integrity Data Sheets and Chain of Custody Records. Sample coolers will be secured with chain of custody seals. Each soil sample will have a unique identification number including Golder (G), the test pit number (i.e., TP2 for test pit # 2), the depth of the sample, and the sample collection date. An example of a soil test pit sample from soil test pit #2 that would be taken from the 10 foot depth on January 13, 2009 would be G-TP2-10-011309. Soil samples obtained from HSA drilled boreholes will be identified by the borehole number (ex. BH2 instead of TP2) and depth from surface for each soil sample.

3.1.1.5 Test Pit and borehole Backfilling

All test pits will be backfilled by a licensed excavation contractor with the soil that was removed from the test pit and marked with flush-mount steel plate (~1 to 2-inch diameter) identification markers flush with the ground surface. Boreholes will be backfilled with bentonite or bentonitic grout from the bottom of the borehole to land surface and marked with a flush-mount steel plate identification markers. These steel plate markers will be provided by the certified surveyor and labeled with the test pit identification number. Using this method, the test pit locations may be located in the future using GPS combined with metal detection methods.

3.1.1.6 Surveying and Geodetic Control

The position of all test pits and boreholes is to be field-located and marked by Golder personnel in a manner that does not interfere with Site operations. Each test pit location will be marked with a flush-mounted steel plate marker that will be surveyed for horizontal coordinates (X and Y) using a differential Global Positioning System (GPS) by Golder field personnel. Additionally, boreholes BH-1 through BH-5 will be surveyed by a certified surveyor using appropriate survey coordinate system at the same time as the monitoring wells (installed as part of Phase II of this investigation) will be surveyed. The test pits will not be surveyed by a surveyor.

3.2 Phase II – Groundwater Investigation

The hydrogeologic study will focus on the groundwater quality directly beneath the Site, and in particular the western portion of the Site where investigation data is absent. A number of monitoring wells installed by EPA and Potlatch currently exist on the eastern portion of the Site. Because no monitoring wells currently exist on the western portion of the Site, a total of four monitoring wells (designated GA-1 through GA-4) will be installed along the western half of the Site. Figure SAP-3 shows the proposed locations of new monitoring wells to be installed and sampled during the field investigation. Well GA-1 will be located between the St. Joe River and the existing monitoring well HC-1R, as shown on Figure SAP-3. Two wells (GA-2 and GA-3) will be located near the river within the western portion of Section 16 Area of the site where investigative data is absent. The fourth well (GA-4) will be installed hydraulically up-gradient (northeast) of the drinking water supply well (DW-01) for monitoring groundwater approaching the supply well (see Figure SAP-3). These additional monitoring wells together with well HC-1R will provide protective monitoring for Site COPCs in the groundwater migrating toward the residential groundwater supply well. The proposed location for GA-1 also provides information of the down-gradient extent of the floating LNAPL on the groundwater table. GA-2 and GA-3 monitoring wells will provide information on potential releases in the western portion of the Site. The monitoring wells will be drilled using air-rotary drilling techniques. HSA drilling will be conducted because historical HSA drilling activities at the Site were successful. Other drilling methods will likely hit refusal when encountering large cobbles

or boulders, but the HSA drilling method is capable of handling some rocky lithology. If refusal occurs during drill, the drill rig will be moved by a few feet and the borehole will be re-drilled. The monitoring wells will be installed with screens traversing the anticipated water table fluctuations. After monitoring well installations are complete, the wells will be surveyed for geodetic x, y, z coordinates and water-level elevations measured to determine groundwater elevations. The new groundwater monitoring wells will also provide a determination of the local groundwater flow and gradient.

The numerous investigations conducted at the site to date determined the groundwater is between 10 and 16 feet bgs with water levels comparable with the St. Joe River surface water. The groundwater is flowing parallel to the river within the eastern portion of the Site (Section 15 Area), based on data collected by Ecology & Environment (2007) and Hart Crowser (2001-2004). The groundwater flow pattern may be influenced from groundwater flowing southward from the mountainside. The Site groundwater appears to change direction and flow toward the southwest and toward the St. Joe River from commingling with mountainside groundwater in the middle portion of the Site (in the area around well HC-4 and around the boundary between Section 15 and 16 Areas). From the groundwater level and the river level measurements, groundwater appears to be discharging to the river within the western portion of the Section 15 Area and the eastern portion of the Section 16 Area. When operational, the private groundwater supply well may locally influence the groundwater flow pattern and discharge to the river.

The groundwater within the western portion of the site is derived from either direct infiltration of meteoric precipitation, from groundwater flowing from the east, or from groundwater flowing from the north. This additional groundwater investigation will help identify flow patterns in the western portion of the Site. Prior to initiating the installation of the new groundwater wells, the groundwater levels and LNAPL thickness must be determined for each existing wells and piezometers, in an effort to identify whether there have been any changes in the LNAPL plume since the last investigation was conducted. If changes in the plume are observed, EPA will be notified and the locations of the proposed soil borings and monitoring wells will be re-evaluated.

This task includes the anticipated sampling and analysis of groundwater by installing new monitoring wells and sampling existing monitoring wells located around the Site to collect additional groundwater quality data. Golder proposes to collect groundwater samples from the eight existing drinking water and groundwater monitoring wells.

The groundwater samples will be obtained during two sampling events. Analyses will be for standard field parameters and constituents of potential concern (COPC) at the Site.

3.2.1 Task 1 - Monitoring Well Drilling and Installation

Four groundwater monitoring wells will be drilled and installed on the western portion of the Site using HSA drilling methods. The monitoring wells will be located at the approximate locations shown on Figure SAP-3. The drilling installation and development of the monitoring wells will be subject to controls and strict quality assurance (QA) protocols and procedures specified in the relevant Golder Technical Procedures referenced below. These technical procedures will be provided if requested.

- TP 1.2-5 “Drilling, Sampling, and Logging Soils”
- TP 1.2-12 “Monitoring Well Drilling and Installation”
- TP 1.2-6 “Field Identification of Soil”
- TP 1.2-23 “Chain of Custody”

The Golder forms to be completed with these technical procedures are contained in the technical procedures.

3.2.1.1 Preparation Activities

Preparation activities for this task include the following:

- Preparing bid package and contracting for certified drilling contractors;
- Coordination with the chemical analytical laboratory;
- Mobilizing necessary field equipment and supplies;
- Obtain necessary drilling permits and START Cards from IDWR; and
- Underground utility locating through public utility locate request;

Before all intrusive subsurface investigation activities, the Potlatch Site Manager shall be notified of the drilling schedule and locations of the anticipated boreholes and a utility locate request will be filed with local utility organizations. All utilities located by the Utility Locating Services will be confirmed as clear before beginning subsurface drilling activities. If additional lines or obstructions are found during this task, subsurface boring locations will be adjusted appropriately to avoid encountering any and all underground utilities.

3.2.1.2 Borehole Drilling and Soil Sample Collection

Monitoring wells will be drilled and installed by a State of Idaho licensed driller using an HSA drill rig. All drilling will be under continuous supervision of a Golder geologist/engineer.

Before arriving at the Site and before drilling each borehole (to prevent cross chemical contamination), the down hole equipment will be steam-cleaned using approved tap water source until no visible dirt remains. The monitoring wells will be installed in order of cleanest to the most likely impacted. Likely, this will mean that GA-3 will be the first drilled and installed well and GA-1 will be the last. The HSA borings will be advanced using nominal 6-inch ID rotary casing advanced continuously. Drilling will stop after penetrating 10 feet into the aquifer water table.

Soil cuttings will be collected for geologic logging at 5-foot intervals throughout the entire borehole and at the interface with the water table and logged by a Golder geologist/engineer in the field using Unified Soil Classification System (USCS) soil descriptions. Samples will only be collected and analyzed if field observations (i.e., visual signs, olfactory senses, and PID measurements) indicate impacted material. If impact is observed, the soil cutting samples will be transferred into glass sample bottles that are appropriate for chemical analyses of the contaminants of potential concern (COPCs) as specified in the QAPP (see Appendix A).

3.2.1.3 *Chemical Analysis of Monitor Well Boring Soil Samples*

Soil samples collected from the well borings to be analyzed will be sent to Test America Analytical Services laboratory in Spokane, Washington for analysis of the following COPCs in accordance with QAPP (Appendix A) requirements:

- Diesel and Heavy Oil Range Total Petroleum Hydrocarbons (NWTHP-Dx)
- PAHs – EPA Method 8270C
- Naphthalene – EPA Method 8270C
- PCBs – EPA Method 8082

The reference analytical methods and required laboratory practical quantification limits (PQLs) are listed in the Table QAPP-4 of the QAPP (Appendix A to this Field Sampling and Analysis Plan).

3.2.1.4 *Sample Nomenclature*

Documentation for sampling will include bottle labels, completion of Sample Integrity Data Sheets and Chain of Custody Records. Sample coolers will be secured with chain of custody seals. Each soil boring sample will have a unique identification number including Golder (G), the boring number (i.e., GA2 for monitoring well GA-2), the depth of the sample, and the sample collection date. An example of a soil boring sample from monitoring well GA-2 that would be taken from the 10 foot depth on January 13, 2009 would be G-GA2-10-011309.

3.2.1.5 *Well Installation*

All well installations will be under continuous supervision of a Golder geologist/engineer. The monitoring well borings will be advanced to a depth of approximately 10 feet below the top of the static groundwater table. Upon completing each of the borings to the desired depth, a monitoring well will be installed and registered in conformance with IDWR well construction regulations (IDAPA 37.03.09) and follow Golder Technical Procedure TP-1.2-12 “Monitoring Well Drilling and Installation”. A schematic installation diagram for the monitoring wells is shown in Figure SAP-4.

All wells will be completed with 2-inch diameter stainless-steel, wire-wrapped well screen and schedule-40 PVC casing with O-rings seal between joints. The well screens will be 15 feet in length and fabricated with 0.020-inch slots, or other appropriate slot size based on encountered formation materials. Shorter screen intervals may be used where appropriate based on lithologies encountered. The monitoring well screens will traverse the anticipated water table fluctuations. To accommodate these fluctuations, the screens will be installed to straddle the water table surface with 5 feet above and 10 feet below the static water level at the time of installation. The casing shall be centered in the hole and a bottom cap shall be attached to the end of the well casing.

Well installation will be conducted inside the drill borehole stabilization casing and the well installation will meet EPA and IDWR requirements. A filter pack shall extend from about 6 inches below the well screen to no more than approximately 3 feet above the topmost slot on the well screen. The filter pack materials shall consist of clean, chemically inert, well sorted silica sand and shall be sized for the formation and the screen slot size. The annulus between the PVC well casing and the wall of the drill casing may be used for the placement of the sand filter during well construction. The drill casing will not be pulled above the depth of the materials placed. As it is being placed, the top of

the filter pack will be measured with a weighted engineering tape. The sand pack will be surged with a surge block (as part of well development to settle the sand before placing the bentonite seal).

After sand pack surging, 5 feet of bentonite pellets or chips will be placed in an unhydrated state immediately on top of the filter pack and subsequently hydrated. At least one hour will be allowed for the bentonite seal to hydrate before the remaining seal is placed. The remainder of the annular space shall be sealed using cement grout with 5 percent bentonite. The cement grout will be placed by injection from the bottom of the open annular space through a tremie pipe. Quick setting cement grout shall not be used as a borehole seal without the approval of the project manager. The top 4 to 5 feet will be filled with concrete as a base for the protective monument.

3.2.1.6 Well Monument Construction

All monitoring wells will be completed with a nominal 8-inch diameter protective steel well monument with a lockable lid. The monument will be flush mounted with the ground surface. At least a 6-inch clearance shall be maintained between the well cap and the monument lid to allow placement of a data logger, if needed.

The protective monument will be painted yellow and given the well designation. The well tag will be attached to the inside of the well monument lid. A 0.25-inch weep hole will be drilled at the base of the monument and the monument's annulus filled with drainage sand or pea gravel. The wells will be capped using a plastic slip cap.

3.2.1.7 Well Development

Following installation of the groundwater monitoring wells, and after adequate time has elapsed for the grout to harden (minimum 24 hours), the monitoring wells shall be developed. Well development is performed to produce representative formation water that is free of drilling fluids, cutting, or other materials potentially introduced during drilling and well construction. Development shall be performed through a combination of surging (via a surge block) and groundwater purging (via bailer or submersible pump). Representative water is assumed to have been obtained when pH, temperature, specific conductance and turbidity readings have stabilized (pH within 0.1 standard pH units, temperature within 0.5 degrees C, conductivity within 10 percent and turbidity within 0.5 nephelometric turbidity units (NTU) and below 2 NTU).

Groundwater produced during purging shall be captured in 55-gallon drums or suitable tank(s) and labeled as "investigative derived wastes" (IDW). Characterization of the water for disposal will be based on results of groundwater sample analysis. Additional IDW sampling may be required before disposal at a licensed Site. Golder will work with Potlatch to manage IDW and may be able to dispose of it during the remedial action, with IDEQ and EPA approval.

3.2.1.8 Well Drop Tube Installation

For wells where LNAPL is suspected to be present, a polyvinyl chloride (PVC, schedule 10) drop tube will be installed in each well. The drop tube will be installed after the thickness of the LNAPL has been estimated. The drop tube will aid in groundwater sampling by protecting the sample collection tubing from LNAPL contamination. The PVC drop tube will be long enough to advance 1 foot below the water level (i.e. 1 foot below the bottom of the LNAPL layer). The bottom of the drop tube is sealed with a piece of tinfoil fixed to the tube by a hose clamp. A ½-inch stainless steel ball will be placed inside of the drop tube so that it rests on the tinfoil. Deionized (DI) water is slowly

added to the drop tube until it has filled drop tube up to 1.25 feet from the bottom. The stainless steel ball and the water will cause the tinfoil to create a meniscus. The drop tube is then lowered into the well until the bottom of the drop tube is 1 foot below the water level. The tinfoil meniscus will prevent any LNAPL from entering the drop tube and will prevent LNAPL from adhering to the outside of the tinfoil. If the tinfoil was placed on the drop tube without the ball or DI water, there is the risk that the water pressure will dimple the tinfoil allowing LNAPL to pool inside of the dimple.

The drop tube will be held in place by a PVC plate (with a hole at its center) that is glued to the outside of the drop tube. The plate will then rest on the top of the well casing thereby suspending the drop tube inside the casing. The drop tube will remain in the well from one to three weeks until the water column has stabilized. A drop tube will be dedicated to each well that has floating LNAPL thereby reducing the risk of cross-contamination.

Before collecting a groundwater sample, the DI water must be removed from the drop tube using a peristaltic pump and ¼-inch HDPE tubing (to eliminate mixing of the DI water and groundwater). Once the DI water has been removed, the tinfoil will then be punctured with a stainless steel rod, causing the stainless steel ball to drop to the bottom of the well. A new piece of ¼-inch HDPE tubing with its end capped will be lowered inside of the drop tube to 1-foot below the bottom of the drop tube (approximately two feet below the water level). The cap will further prevent LNAPL from coming in contact with the sample tubing intake. Connect the ¼-inch tubing to a peristaltic pump and run the pump in reverse flow so that the air pressure blows the cap off of the tubing. Low-flow sampling can commence once the cap is off the tubing.

The drop tube will remain in place until the end of the second groundwater sampling event, after which the drop tube will be removed. After removal of the drop tube (and after several hours of equilibration) the thickness of LNAPL will be estimated for a second time in each well.

3.2.1.9 Monitoring Well Geodetic Survey

Following completion of the installation of monitoring wells, the wells will be geodetically surveyed. All new wells and existing monitoring wells that are used in the investigation will be surveyed by a certified surveyor using appropriate survey coordinate system. Surveying the wells will be conducted by a certified professional land surveyor licensed in the State of Idaho. Each monitoring well will be surveyed for geodetic X, Y and Z coordinates. Monitoring wells will have elevation (Z-coordinate) surveyed for:

- Ground surface elevation
- Top of monument elevation
- Top of PVC drop tube plate or PVC casing (if no drop tube is installed) at measuring point elevation
- Surface location in units of northings and eastings

All elevations on the wells will be surveyed to third order accuracy and precision. Elevation surveys will have an accuracy and precision of at least 0.02 foot for water elevation measurement. Surveys will reference the site-specific coordinate system used for previous investigations.

3.2.2 Task 2 - Groundwater Sampling

After development activities are completed and the aquifer has had at least one week to stabilize, groundwater samples will be collected. Two groundwater sampling events are proposed for EE/CA investigation to confirm analytical results. Groundwater samples will be collected from all the new groundwater monitoring wells (GA-1 through GA-4) and from existing wells DW-01, HC-1R, EMW-04, MW-11, EW-3, EMW-06, EW-4, and MW-5 (depicted on Figure SAP-3). The selected monitoring wells provide aerial coverage of the groundwater impacts on-Site.

Groundwater quality sampling activities will be conducted in accordance with protocols and procedures specified in the relevant Golder Technical Procedures referenced below. These technical procedures include the following, and will be provided if requested.

- TP-1.4-6a “Manual Water Level Measurements”
- TP-1.2-20 “Collection of Groundwater Quality Samples”
- TP-1.2-23, “Sample Handling, and Chain of Custody”

The Golder sample forms to be completed with these technical procedures are contained in the technical procedures.

Preparation activities for this task include:

- Requesting necessary field groundwater sampling equipment and supplies;
- Obtaining 55-gallon drums (or appropriate) for the collection of purge water; and
- Locating appropriate decontamination area at the Site.

3.2.2.1 *Groundwater Sampling Activities*

Sample collection and handling will be performed appropriately in accordance with the QAPP. All instruments used for field analysis will be calibrated in accordance with manufacturer's recommendations. Chain of custody will be maintained appropriately by the field crew members.

Groundwater sampling activities from the monitoring wells will include the following activities:

- Inspection of each well for the presence of floating LNAPL, including all new and existing wells and piezometers;
- Estimate the thickness of floating LNAPL, if present;
- Measurement of static water levels in all new and existing wells and piezometers;
- Collection of floating LNAPL samples from MW-11 and HC-4;
- Groundwater samples will be obtained using Low-Flow groundwater sampling techniques;
- Measurement of field parameters (pH, specific conductance, temperature, dissolved oxygen, and turbidity) during purging with field sampling equipment;
- Sampling of groundwater when the field parameters indicate that the well has been adequately purged;

- Collection of representative groundwater samples in appropriate containers for COPCs;
- Collection of a filtered groundwater sample for dissolved metals analysis;
- Preservation and proper storage of each sample; and
- Collection of all purge water in appropriate containers for temporary on-site storage before disposal.

Each well will be inspected for the presence of floating LNAPL using a product detecting meter. The static water level will be measured at all monitoring wells before initiating any groundwater purging activities. Monitoring wells with floating LNAPL will need to be sampled through a drop tube discussed in Section 3.2.1.8. All wells (with or without LNAPL) will be sampled using a peristaltic pump and HDPE ¼-inch tubing with a cap on one end. The cap will further prevent floating LNAPL or LNAPL sheen from contacting the sample tubing intake through carry-down. Connect the ¼-inch tubing to a peristaltic pump and run the pump in reverse flow so that the air pressure blows the cap off of the tubing. Low-flow sampling can commence once the cap is off the tubing. It is not anticipated that a large LNAPL thickness will be encountered that hinders groundwater sample collection using a peristaltic pump, but in the event this occurs, a bailer will be used.

The groundwater monitoring wells will be purged at a low-flow rate for sample acquisition, such that water table drawdown is less than 0.3 feet. Dedicated tubing will be used for each well. Intakes for the pump or sampling tube will be set at the center of the water column in the screened intervals, or two feet below the water level.

During well purging, field parameters pH, conductivity, turbidity, dissolved oxygen, and temperature will be measured every 5 minutes. The instruments used in the field parameter measurements will be field calibrated per the manufacturers' specifications and as described in the QAPP at the beginning of the day. Purging will be conducted until the measured rate of change of these parameters is in accordance with TP-1.2-20 on consecutive readings. Turbidity must be less than 5 NTU for the sample to be considered representative of groundwater conditions. All field parameter measurements and purge volumes will be recorded on Sample Integrity Data Sheets.

A filtered groundwater sample will also be collected from each well after the collection of unfiltered groundwater samples. The filtered sample will be collected using an inline 0.45 micron filter. The filtered sample will be sent to the laboratory, but will be archived until unfiltered sample results are reviewed by Golder.

3.2.2.2 Floating LNAPL Sampling Activities

Floating LNAPL samples will be collected from MW-11 and HC-4 because these wells were found in the past to have a significant thickness of floating LNAPL. The floating LNAPL sample should be collected from the well after collecting a groundwater sample; however, no groundwater sampling will be conducted in HC-4. A new piece of HDPE ¼-inch tubing should be used to collect the LNAPL sample. The sample will be collected in appropriate sample containers and analyzed for all groundwater COPCs. Other wells with floating LNAPL will not be sampled because the amount of LNAPL available is not enough for sample collection. If, however, other wells are found to have a significant thickness of floating LNAPL (greater than 0.5 inches), EPA will be notified and the LNAPL in that well will be collected for analysis.

3.2.2.3 *Sample Nomenclature*

Documentation for sampling will include bottle labels, completion of Sample Integrity Data Sheets and Chain of Custody Records. Sample coolers will be secured with chain of custody seals. The Sample Integrity Data Sheet will be used to document sample collection information, as further described in the QAPP. A unique identification number shall be given to each groundwater sample that includes Golder (G), the well number (i.e., GA2 for monitoring well GA-2), and the sample collection date. An example of a groundwater sample from monitoring well GA-2 collected on January 13, 2009 would be G-GA2-011309. A floating LNAPL sample will additionally have the letters FP (Floating Product) behind the monitoring well number (i.e. G-MW11FP-011309).

3.2.2.4 *Chemical Analysis of Groundwater Quality and LNAPL Samples*

Groundwater COPCs have been determined and based on documented historical activities at the Site, known materials to be stored on the Site, and reported hazardous substances that were used at the Site. These COPCs are presented and discussed in the QAPP. Groundwater and LNAPL samples will be analyzed at Test America Analytical Services laboratory in Spokane, Washington. All unfiltered groundwater and LNAPL samples will be analyzed for the following components:

- Diesel and Heavy Oil Range Total Petroleum Hydrocarbons (NWTHP-Dx)
- PAHs – EPA Method 8270C
- Naphthalene – EPA Method 8270C
- PCBs (only from GA-1, GA-2, GA-3, and GA-4 wells and LNAPL samples) – EPA Method 8082. New wells must be sampled for PCBs in order to establish a baseline. Wells that have been sampled for PCBs in the past do not need to be sampled again.
- Metals – EPA Method 6010C/0620A Series and EPA Method 7470A for mercury. Metals include aluminum, arsenic, antimony, beryllium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver, thallium, and zinc.

Golder will make the determination of whether filtered groundwater quality samples will be analyzed after unfiltered groundwater results are received. Filtered groundwater quality samples will only be analyzed if warranted based on unfiltered sample turbidity results and analytical results that are above screening criteria. The reference analytical methods and required laboratory PQLs are listed in the Table QAPP-4 of the QAPP (Appendix A of this Field Sampling and Analysis Plan).

3.2.3 Task 3 - Groundwater Hydraulic Gradient Investigation

To better understand the flow of groundwater at the Site, all new and existing monitoring wells will be monitored for groundwater level (elevation) changes. Using an oil/water interface probe, the water level and the LNAPL level (if present) will be measured in each well. The thickness of the LNAPL can also be measured using a bailer. Monitoring wells with floating LNAPL will have the water level corrected for the thickness of the LNAPL present. The correction factor includes multiplying the LNAPL thickness in the well by the specific gravity of the LNAPL, then adding this amount to the elevation of the water level in well (EPA, 1995). The St. Joe River is expected to influence the flow of Site groundwater based on antecedent infiltration and river stage. Elevation survey data for each existing monitoring well will be obtained from the EPA. The additional monitoring wells installed by Golder will be surveyed to the same datum as the other Site wells. The water levels in all of the wells

will be monitored monthly, depending on weather conditions for access, beginning prior to the initiation of the soil and groundwater investigations.

Water level monitoring will be compared to changes in the St. Joe River to better understand the influence various river stages have on Site groundwater flow patterns. A temporary staging station will be installed near the Site on the St. Joe River for measurements of river water levels. The upstream bridge at Avery, Idaho may be used to establish a temporary river stage station if one does not exist in the area. The water level data collected from the monitoring wells and the St. Joe River will be used to understand changes in groundwater flow patterns during different seasons and during changes in the stage of the river.

Groundwater hydraulic gradient investigations will be conducted in accordance with protocols and procedures specified in the relevant Golder Technical Procedures. The technical procedure for this task includes TP-1.4-6A "Manual Water Level Measurements". The technical procedures will be provided if requested. The Golder sample forms to be completed with these technical procedures are contained in the technical procedures.

Groundwater hydraulic gradient investigation includes the following activities on a monthly basis:

- Requesting necessary field equipment and supplies prior to event;
- Obtaining permission from adjacent property owners to collect groundwater levels from existing wells (if required) prior to event;
- Inspection of each well for the presence of floating LNAPL;
- Estimate the thickness of floating LNAPL, if present;
- Measurement of static water levels in monitoring wells; and
- Measurement of river water level from either the upstream bridge at Avery, Idaho or a temporary staging station.

Water levels in monitoring wells should be measured from the cleanest wells first and the wells with floating LNAPL last. Decontamination of the water level meter should be conducted between each well.

3.2.4 Task 4 - Groundwater Hydraulic Tests

Short-term hydraulic slug tests will be performed on four selected monitoring wells (from the list of existing and new wells). The selection of wells for slug-testing will be based on well installation documentation, field inspections, and aerial representativeness. The need and implementability for a long-term pump test will be evaluated based on the results of the short-term slug-test.

If it is deemed necessary (based upon observed conditions in the monitoring wells), we may conduct a single well drawdown and recovery test. Water level fluctuations will be recorded using a down hole pressure transducer equipped with a data acquisition system.

The slug test investigation will be conducted in accordance with protocols and procedures specified in the relevant Golder Technical Procedures referenced below. These technical procedures include the following, and will be provided upon request:

- TP-1.2-17 Rising Head Slug Test
- TP-1.4-11 Single Borehole Drawdown and Recovery Pump Test

The Golder sample forms to be completed with these technical procedures are contained in the technical procedures.

Preparation activities for this task include:

- Reviewing existing monitoring well data;
- Requesting necessary field groundwater sampling equipment and supplies;
- Obtaining 55-gallon drums (or appropriate) for the collection of purge water; and
- Locating appropriate decontamination area at the Site.

3.3 Phase III – Near Shore Investigation

The St. Joe River LNAPL seep, surface water, and sediments will be sampled along the river embankment to assess discharges and impacts from the Site. The river stations are shown on Figure SAP-3. There are a total of eight near shore sampling locations labeled RS-1 through RS-8. RS-1 will represent up-river background for comparison to the remainder sampling locations. Only one sediment sampling event will take place. There will be two LNAPL and surface water sampling events that will coincide when LNAPL is visibly discharging along the river's edge during low river flows (typically summer and fall seasons). All of the river stations need to be marked by survey stakes (or similar) so that the river stations can be easily located over the course of sampling events. The near shore investigation will be conducted by two field personnel for safety reasons due to the proximity to water. At no time will the field personnel enter the water to collect near shore samples.

3.3.1.1 Near Shore Sediment Sampling Activities

The near shore sediment investigation will be conducted in accordance with protocols and procedures specified in the relevant Golder Technical Procedures referenced below. These technical procedures include the following, and will be provided upon request:

- TP-1.2-24 Sediment Sampling
- TP-1.2-23, Sample Handling, and Chain of Custody

The Golder sample forms to be completed with these technical procedures are contained in the technical procedures.

Preparation activities for this task include:

- Coordination with the chemical analytical laboratory
- Mobilizing necessary field equipment and supplies

Two sediment samples will be collected from each river station. One sample will be collected at the shoreline (Right below the water line) and the second one will be collected approximately three to four feet from the shoreline (in the water). The banks of the St. Joe River are rip-rap lined, so the shoreline sediment sample will be collected as close to the waterline as practical, wherever the

sediment has been deposited. The shoreline samples will be collected from the surface of the sediment (upper 3-4 inches) using a pole-mounted drive tube with a sand catching assembly. A stainless steel spoon or trowel will be used to transfer the sediment into the laboratory provided container. All sampling equipment will be decontaminated between each sample. Each sediment core sample will be visually inspected for its petroleum content to identify if any smearing of petroleum has occurred during fluctuations of river levels. Any differences in petroleum content between the surface and the bottom of the core sample will be noted. The entire sediment core sample will be transferred directly into a laboratory provided container for chemical analysis.

The second sample (three to four linear feet from the shoreline) will also be collected from the surface of the sediment (upper 3-4 inches) using a pole-mounted drive tube with a sand catching assembly. The sampler will stand on the rip-rap along the river's edge and will use the pole-mounted drive tube to reach the sediment located three to four linear feet from the shoreline. At the time of the sediment sampling, it is not anticipated that the river depth will be very deep. The drive tube with a pole (or extended handle) will be driven through the water into the sediment so that the upper 3-4 inches of surface sediment can be sampled. The drive tube assembly will prevent the sediment from being washed away as it is pulled up through the water column. The sediment will either be directly placed in the laboratory provided container from the drive tube or a stainless steel spoon will be used to transfer the sediment from the drive tube into the sample jars. All sampling equipment will be decontaminated between each sample. An alternative sampling method to the drive tube would be a hand auger with an extended handle.

3.3.1.2 Near Shore LNAPL and Surface Water Sampling Activities

The near shore LNAPL and surface water investigation will be conducted in accordance with protocols and procedures specified in the relevant Golder Technical Procedures referenced below. These technical procedures include the following, and will be provided upon request:

- TP-1.2-26 Surface Water Sampling Methods
- TP-1.2-23 Sample Handling, and Chain of Custody

A Golder Technical Procedure does not exist for LNAPL sample collection. The Golder sample forms to be completed with these technical procedures and sampling efforts are contained in the technical procedures.

Preparation activities for this task include:

- Coordination with the chemical analytical laboratory;
- Mobilizing necessary field equipment and supplies.

Two LNAPL and surface water sampling events will occur. Each event will occur when LNAPL is visibly discharging along the river's edge during low river flows (typically summer and fall seasons). LNAPL will be collected from the surface water sampling stations along the river bank, if any LNAPL is present. Golder will obtain a sample of LNAPL that accumulates behind the oil floatation booms adjacent to a river sampling station by carefully skimming the LNAPL directly into laboratory provided clean sample vials. The laboratory will be instructed to use only the LNAPL for sample analysis.

Surface water samples will be collected from the eight river stations depicted in Figure SAP-3 (the same locations where the sediment samples were collected). Surface water samples will be obtained below the river water surface from about the mid-depth. Since the surface water samples are to be obtained adjacent to the river's edge (~ 1 foot from the shore), the depth of the river is expected to be very shallow. Therefore, depth discreet surface water samples will not be necessary. Unfiltered surface water grab samples will be collected directly from the river if there is no visible floating LNAPL present at a specific sampling station either by filling laboratory provided sample containers directly (if there is not an acid preservative in the sample container) or by using a laboratory cleaned glass cup, the contents of which would then be transferred into the laboratory provided containers. Sampling surface water below a floating LNAPL will be conducted by lowering a dedicated HDPE 1/4-inch tubing to a peristaltic pump with a plastic cap below the LNAPL layer. The cap will be blown off the sampling tube by reversing the air flow with the pump. The sample will then be obtained by pumping surface water with the peristaltic pump directly into the sampling containers with appropriate preservatives.

Filtered surface water samples will also be collected at each river station by using dedicated HDPE 1/4-inch tubing, a dedicated inline 0.45-micron filter, and a peristaltic pump by filtering water pumped directly out of the surface water body into laboratory provided containers with appropriate preservatives. Filtered surface water samples will be collected so that the results can be compared to aquatic water quality standards. The filtered surface water samples will be analyzed for hardness-dependent metals (see Section 3.3.1.4 for details), but the remaining filtered surface water sample will be archived in case further analysis is warranted based on the analytical results of the unfiltered surface water samples.

Water quality parameters (temperature, pH, conductivity, dissolved oxygen, and turbidity) will also be monitored at each river station where a sample is collected. The water quality parameters will be recorded on a Sample Integrity Data Sheet.

3.3.1.3 Sample Nomenclature

Documentation for sampling will include bottle labels, completion of Sample Integrity Data Sheets and Chain of Custody Records. Sample coolers will be secured with chain of custody seals. The Sample Integrity Data Sheet will be used to document sample collection information, as further described in the QAPP. A unique identification number shall be given to each sediment, LNAPL, and surface water sample that includes Golder (G), the river station number (i.e., RS2 for river station number RS-2), the type of sample it is (SED for sediment, FP for LNAPL/floating product, and SW for surface water), sediment sample location from the shoreline (for sediment samples only- 0 for shoreline samples and 3 for samples collected 3 feet from the shoreline), and the sample collection date.

An example of a sediment sample from river station RS-2 collected at 3 feet from the shoreline on January 13, 2009 would be G-RS2SED-3-011309. A floating LNAPL sample will additionally have the letters FP (Floating Product) behind the monitoring well number (i.e. G-MW11FP-011309). A surface water sample collected from river station RS-2 collected on January 13, 2009 would be G-RS2SF-011309.

3.3.1.4 *Chemical Analysis of Sediment, Surface Water and LNAPL Samples*

Sediment, LNAPL, and surface water COPCs have been determined and based on documented historical activities at the Site, known materials to be stored on the Site, and reported hazardous substances that were used at the Site. These COPCs are presented and discussed in the QAPP. Sediment, LNAPL, and surface water will be analyzed at Test America Analytical Services laboratory in Spokane, Washington for the following components:

- Diesel and Heavy Oil Range Total Petroleum Hydrocarbons (NWTHTP-Dx)
- PAHs – EPA Method 8270C
- Naphthalene – EPA Method 8270C
- PCBs – EPA Method 8082
- Metals (only for unfiltered surface water and LNAPL samples as described in the Work Plan) – EPA Method 6010C/6020A Series. Metals include aluminum, arsenic, antimony, beryllium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver, thallium, and zinc. Filtered surface water samples will only be analyzed for hardness dependent metals, which include cadmium, chromium, copper, lead, nickel, silver, and zinc. The filtered surface water samples will also be archived in case additional analysis is warranted based on unfiltered water sample results.
- Metals (only for sediment samples) – EPA Method 6010C/6020A Series. Only arsenic, cadmium, iron, lead, nickel, manganese, and zinc will be analyzed. The limited metal analyte list for sediment samples represents metals that were detected above sediment screening levels or water quality criteria (see QAPP in Appendix A to this SAP) in site soils and groundwater, respectively, during previous investigations.

The reference analytical methods and required laboratory PQLs are listed in the Table QAPP-4 of the QAPP (Appendix A to this Field Sampling and Analysis Plan).

4.0 FIELD INVESTIGATION SUPPORTING PROCEDURES

The preceding section identified those tasks that will be completed to fulfill the requirements of the EE/CA. The following section provides the procedures required to support the EE/CA tasks.

4.1 Field Health and Safety

A Site specific Health and Safety Plan for EE/CA investigations are provided in Attachment C to the Avery Landing EE/CA Work Plan. Key elements of on-Site safety will be communicated to the field personnel, including personal protective measures and equipment, emergency preparedness, and incident protocol. Due to the remoteness of the Site, the Health and Safety Officer will also ensure adequate communication equipment is available to field personnel for contact in the case of field emergencies. The Health and Safety Plan will be reviewed by all field personnel and a tailgate health and safety meeting will be conducted at the beginning of each day. The Health and Safety Plan will be kept with field personnel on-Site at all times.

4.2 Field Quality Control Samples

All field QC procedures, field and laboratory QC samples, and laboratory analytical methods to be used during the EE/CA investigations are provided in the Avery Landing Quality Assurance Project Plan (QAPP) in Appendix A to this Field Sampling Plan. The primary laboratory for analysis of samples is Test America in Spokane, Washington. Split samples will be sent to OnSite Environmental in Redmond, Washington for analysis.

4.3 Sample Handling, Sample Shipment and Sample Custody

This section provides details on sample handling, shipment, and custody.

4.3.1 Sample Handling

All samples will be placed into appropriate containers as indicated in Tables QAPP-3 and QAPP-4 of the QAPP (Appendix A). All sample containers will be supplied by the project analytical laboratory.

As discussed previously, each sample will be assigned a unique identification number, which will be used on chain of custody sheets, sample labels, and field logbooks for identification and tracking purposes and for use in the project database. The samples will be labeled immediately after collection in the field with the sample identification number, location, depth, date and time of sample collection, and any special handling instructions.

All samples will be placed on ice in a cooler immediately after collection and during shipment to the laboratory. While awaiting shipment, samples will be stored temporarily in a secured area under custody by the sampler. All samples will be shipped in sealed ice chests with leak-proof ice-filled bags sufficient to maintain a temperature of approximately 4°C for 48 hours. Custody seals will be placed on each cooler or package of samples. Packing material will be used to prevent breakage and shifting of sample containers during shipping.

4.3.2 Sample Shipment

Samples will be transported to the analytical laboratory by common overnight express carrier or hand delivered. Samples will be shipped no later than five days following collection. The analytical laboratory will be notified of each sample shipment when samples are shipped. Documentation that

samples were received by the analytical laboratory shall be obtained via fax or email the day of arrival at the laboratory.

4.3.3 Sample Custody

Chain of custody documentation will be maintained for each sample collected. The chain of custody form will provide an accurate written record verifying that the samples were under appropriate custody at all times before arrival at the laboratory. Chain of custody will be conducted in accordance with Golder Technical Procedure TP 1.2-23 "Chain of Custody".

The chain of custody will be signed by each individual who has possession of the samples until they are delivered to the laboratory. A copy of the chain of custody will be retained for record management purposes. Each form will be placed in a water-tight plastic bag taped to the underside of the lid of the cooler containing the samples designated on the form. Coolers will be sealed with custody seals. Upon arrival at the laboratory, samples will be received and inspected by a laboratory representative. Samples contained in the shipment will be compared to the chain of custody to ensure that all samples were received and that analytical instructions are clear. The laboratory shall then provide confirmation to field personnel via fax that the samples were received.

4.4 **Documentation Requirements and Record Management**

All data collection and relevant field activities overseen by each field individual shall be documented in chronological order in a controlled permanently bound field logbook. Each logbook will be labeled with the project specific job number, project title, and sampling individual's name. All entries into the logbook will be made using blue or black permanent ink. Entries shall be legible, complete, and accurate. Sufficient information will be recorded to allow the reconstruction of events based on entries without the reliance on personal recollections. Corrections will be made by drawing a single line through the revised text and initialing and dating the correction. Each page in the logbook will be signed and dated by the person responsible for the day's entries.

The information recorded in the logbook will include, but not be limited to, the following:

- Date of field activity
- Weather conditions
- Names of personnel present and activities being conducted
- Start and finish times of individual activities
- Descriptions of sample locations
- Descriptions of samples collected and time
- Relevant conversations

All samples will be recorded on Sample Data Sheets (SDS). The Sample Data Sheets will be kept in a 3-ring binder logbook maintained at the field Site. Sample Identification Numbers will be pre-printed and placed in the logbook for assignment to individual samples as they are collected. The logbook will be maintained by sample collection personnel onsite.

4.5 Decontamination of Drilling and Sampling Equipment

All direct sampling equipment (not including drill rods) will be decontaminated before the start of sampling activities and between each use. The sampling equipment will be washed with a nonphosphate detergent (Alconox or equivalent) solution using brushes to remove all visible dirt and grit. A tap or approved water rinse will be used to thoroughly remove all detergent solution followed by a rinse with dilute hydrochloric or acetic acid. The final rinse will be distilled/deionized water. Should soil or other visible matter remain on the sampling equipment after the detergent/water wash, a wet tap water towel will be used to remove material and the full-complement of decontamination procedures repeated. If the material cannot be removed, the equipment will be retired and not used again. All decontamination rinsates produced during sampling will be collected in suitable containers for temporary on-site storage. The results of the soil sampling and analysis will be used to determine appropriate means of decontamination rinsate disposal. The decontamination rinsates will be disposed of in accordance with all applicable regulatory requirements. Further details on decontamination are provided in the QAPP (Appendix A).

Drill rods shall be either steam cleaned with a non-phosphate detergent and tap water or with an approved water source until all dirt and oil is removed.

4.6 Investigative Derived Waste

Investigation derived waste (IDW) will be generated on the Site during test pitting, well drilling, and well purging. All borehole waste cuttings will be containerized onsite during drilling activities as they are generated. Each container (likely a 55-gallon drum) will identify the specific borehole, from which the waste soils were derived, on its label. Soil cuttings will be monitored in the field using visual indicators, olfactory screening, and PID measurement techniques to indicate the presence of possible hazardous substances contained in the waste cuttings. Any waste cuttings determined or suspected to contain hazardous substances will remain containerized and will be disposed of as “investigative derived wastes” at an appropriate disposal Site. Laboratory analytical results will help determine the appropriate disposal method. If analytical results indicate that borehole waste cuttings do not contain hazardous substances, those containers will be declared as clean and will be emptied in an appropriate area on-Site.

Purge water associated with monitoring well installation and development will be contained and segregated in 55-gallon sealed drums (Type 17H) and stored on the Site at a remote location before off-site disposal. The drums will be labeled as outlined in the QAPP (see Appendix A). Groundwater quality data for each well will be used to characterize the purge water for proper disposal.

Used protective clothing, gloves, etc. will also be managed on the Site according to IDEQ requirements. These will be placed in 55-gallon labeled drums, stored adjacent to the purge water drums, and disposed of at a later date according to its chemical characteristics. Additional IDW sampling may be required before disposal of IDW at a licensed Site. Golder will work with Potlatch to manage IDW and may be able to dispose of it during the remedial action, with EPA approval.

5.0 BIBLIOGRAPHY

Ecology & Environment, Inc. 2007. *Avery Landing Site – Removal Assessment Report*, prepared for the U.S. Environmental Protection Agency, Contract Number EP-S7-06-02, TDD 07-03-0004, Seattle, Washington. April 10.

EPA (United States Environmental Protection Agency). 1994a. Soil Sampling. Standard Operating Procedure #2012. U.S. Environmental Protection Agency. Environmental Response Team. Available from: http://www.ert.org/media_resrcs/media_resrcs.asp.

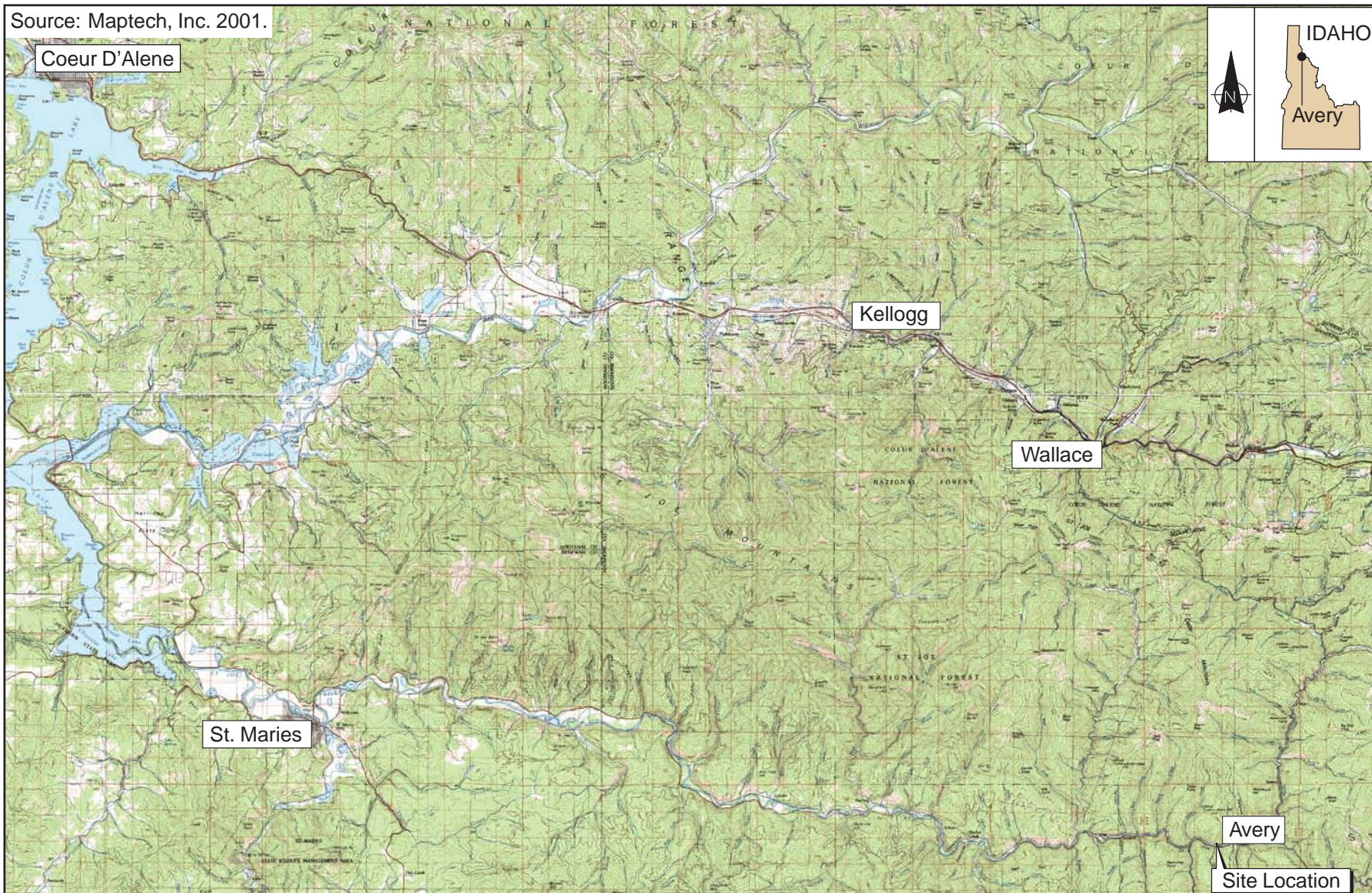
EPA (United States Environmental Protection Agency). 1994b. General Field Sampling Guidelines. Standard Operating Procedure #2001. U.S. Environmental Protection Agency. Environmental Response Team. Available from: http://www.ert.org/media_resrcs/media_resrcs.asp.

EPA (United States Environmental Protection Agency). 1995. Light Nonaqueous Phase Liquids. Ground Water Issu. U.S. Environmental Protection Agency. Authored by Charles J. Newell, Steven D. Acree, Randall R. Ross, and Scott G. Huling. EPA/540/S-95/500.

Hart Crowser, Inc. 2001 through 2004. Quarterly Performance Reports, Avery Landing Recovery System, prepared for Potlatch Corporation.

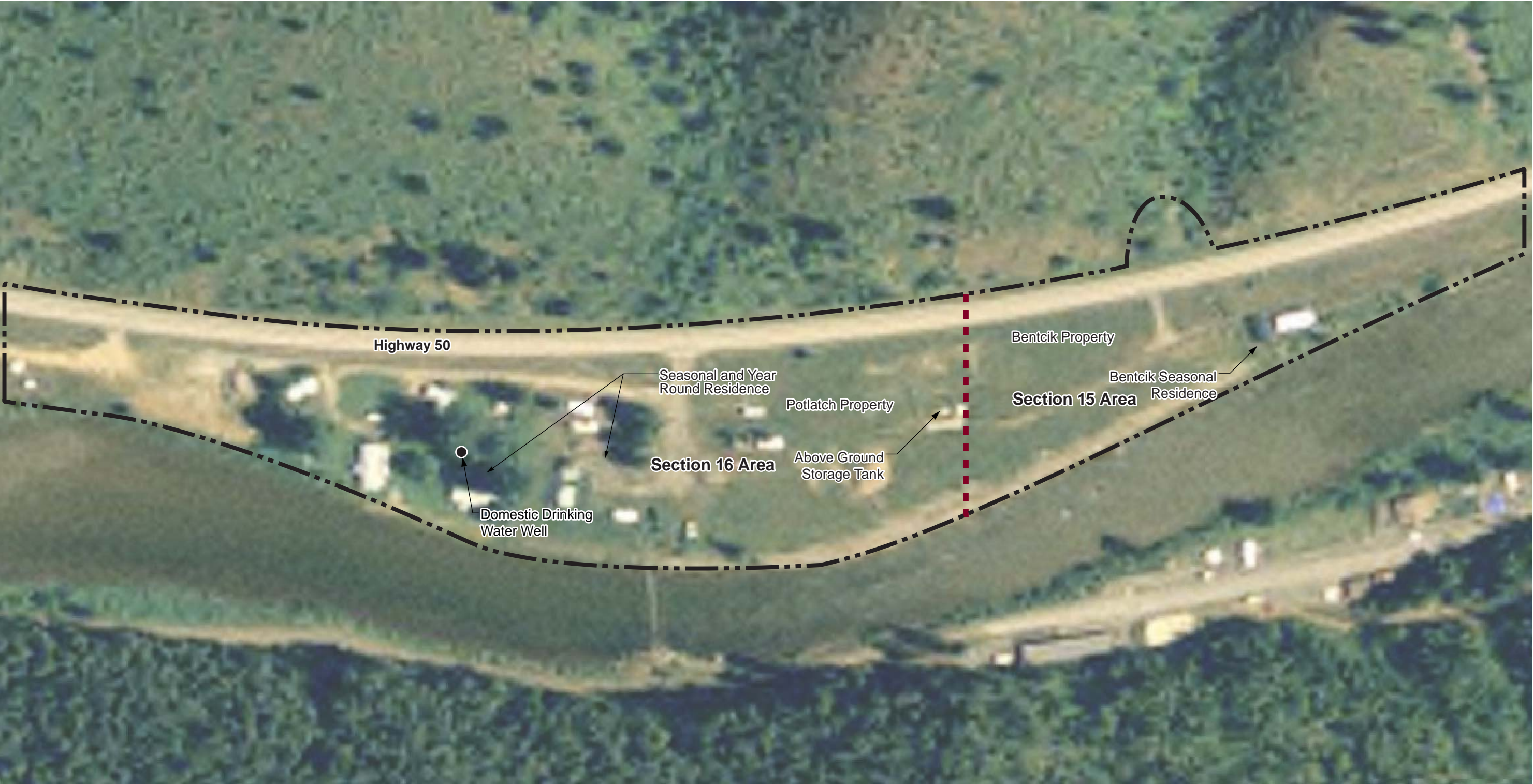
FIGURES

Source: Maptech, Inc. 2001.



Source: Ecology and Environment, Inc., 2007

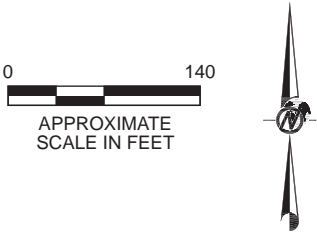
FIGURE **SAP-1**
SITE LOCATION MAP
EE/CA WORK PLAN AVERY LANDING SITE/WA



LEGEND

--- Property Line & Section 16-15 Division Line

[- - -] Site Boundary



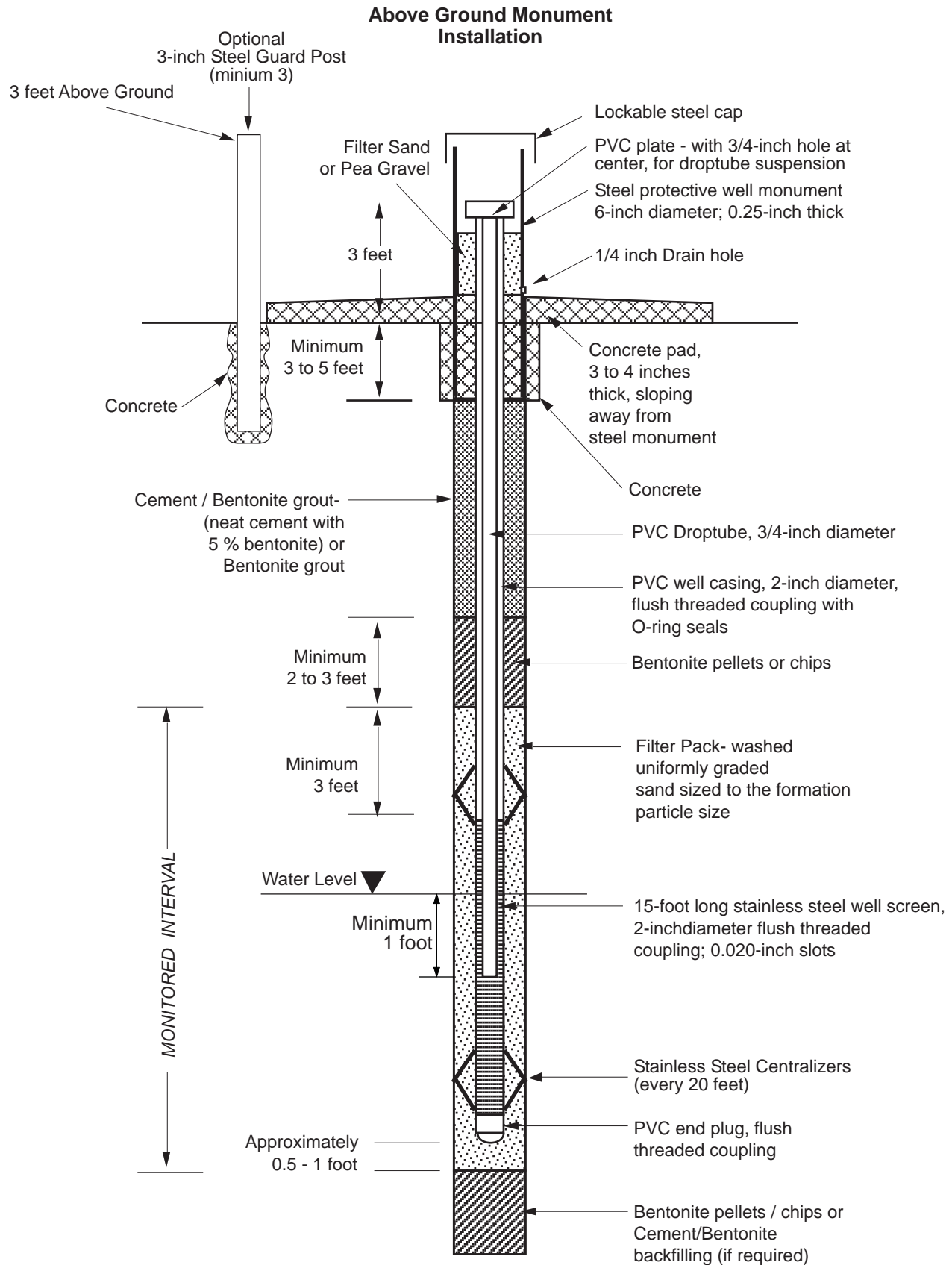


LEGEND

- | | | |
|--|---|--------------------------------|
| --- Property Line
& Section 16-15 Division Line | ● Surface Water Sample Location | ■ Treatability Study Test Pits |
| [---] Site Boundary | ● Proposed EE/CA Monitoring Well | |
| ⊕ EPA Monitoring Well | ▲ Proposed River Sediment and Floating LNAPL
and Surface Water Sampling Location | |
| ● EPA Soil Boring | ■ Proposed Test Pits for Soil Sampling | |
| ● Monitoring Well | ○ Proposed Borehole for Soil Sampling | |
| ● Domestic Well | ○ Proposed Angled Borehole for Soil Sampling | |



FIGURE **SAP-3**
EE/CA INVESTIGATION SAMPLING LOCATIONS
EE/CA WORK PLAN AVERY LANDING SITE/WA



NOT TO SCALE

FIGURE **SAP-4**
SCHEMATIC MONITORING
WELL INSTALLATION DIAGRAM
 EE/CA WORK PLAN AVERY LANDING SITE/WA

APPENDIX A

QUALITY ASSURANCE PROJECT PLAN



Golder Associates Inc.

18300 NE Union Hill Road, Suite 200
Redmond, Washington 98052-3333
Telephone (425) 883-0777
Fax (425) 882-5498
www.golder.com



DRAFT

**QUALITY ASSURANCE PROJECT PLAN
FOR
ENGINEERING EVALUATION / COST ANALYSIS
AT THE AVERY LANDING SITE
AVERY, IDAHO**

Submitted to:

*Mr. Terry Cundy
Potlatch Land and Lumber, LLC*

Submitted by:

*Golder Associates Inc.
18300 NE Union Hill Road, Suite 200
Redmond, Washington*

DRAFT

Douglas J. Morell, Ph.D., P.G., P.Hg.
Principal

DRAFT

Tom Stapp
Senior Chemist

May 13, 2009

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QAPP-3	Sample Container Types, Volumes, Handling, Preservation, and Holding Times; Soil
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QAPP-5	Potlatch Land and Lumber, LLC / Avery Landing Site / Priority Pollutant Metals / Cleanup Limits
QAPP-6	Potlatch Land and Lumber, LLC / Avery Landing Site / Polyaromatic Hydrocarbons/ Petroleum Cleanup Limits
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LIST OF FIGURES

QAPP 1-1	Golder Project Organization
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LIST OF ATTACHMENTS

Attachment 1	Regulatory Screening Level Criteria
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GLOSSARY**ACRONYM AND ABBREVIATION LIST**

AOC	Administrative Order on Consent
ARAR	applicable, relevant, or appropriate requirements
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
EE/CA	Engineering evaluation/cost analysis
EPA	U.S. Environmental Protection Agency
FCR	Field Change Request
Golder	Golder Associates Inc.
HASP	Health and Safety Plan
IDEQ	Idaho Department of Environmental Quality
ICN	Interim Change Notice
IDW	Investigative derived waste
LCS	Laboratory control sample
MCL	Maximum contaminant level
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
MS/MSD	Matrix spike and matrix spike duplicate
µg/L	Microgram/liter
NWTPH-Dx	Northwest Total Petroleum Hydrocarbons for diesel and extended range organics
NWTPH-HCID	Northwest Total Petroleum Hydrocarbons for hydrocarbon identification
PAHs	Polynucleated aromatic hydrocarbons
Potlatch	Potlatch Land and Lumber, LLC and Potlatch Corporation
PRP	Potentially Responsible Party
PQL	Practical quantitation limits
QC	Quality Control
QAPP	Quality Assurance Project Plan
SID	Sample Integrity Data
SAP	Sampling and Analysis Plan
Site	Avery Landing Site, Avery Idaho
Work Plan	Engineering Evaluation/Cost Analysis Work Plan for the Avery Site

1.0 INTRODUCTION

1.1 Project Objective

This Quality Assurance Project Plan (QAPP) is prepared for removal actions at the Avery Landing Site (Site), and in support of the Engineering Evaluation / Cost Analysis (EE/CA) Work Plan (Work Plan) prepared by Golder Associates Inc. (Golder) for Potlatch Land and Lumber, LLC (Potlatch). This QAPP is Appendix A to the Sampling and Analysis Plan (SAP) and will be used in conjunction with the Work Plan. The QAPP was prepared in substantial accordance with the document EPA QA/R-5, 'EPA Guidance for Quality Assurance Project Plans' (EPA, 2001) and provides procedures for making accurate measurements and obtaining representative, accurate, and precise analytical data.

1.2 Site Background and History

The Site is located in the St. Joe River Valley in the Bitterroot Mountains in northern Idaho and encompasses approximately 10 acres. The Site borders the St Joe River about 0.75 miles west of the town of Avery, Idaho. The Site was used as a Milwaukee Railroad maintenance and fueling station from 1907 to 1977, and contained a railroad roundhouse, maintenance, repair, and fueling depot. Presently the Site is relatively flat ground with gravel and sparse vegetative growth and few structures remain.

There are primarily four properties located on the Site: The Federal Highway Administration property includes Highway 50 and its easement; the Bencik property includes the eastern half of the Site with numerous monitoring wells and piezometers for monitoring groundwater; the Potlatch property with several buildings and utility hook-ups on its western portion and, the State of Idaho property consisting of the bed and banks of the St. Joe River. A domestic groundwater supply well is in the western portion of the Potlatch property for use by residents and visitors. The eastern portion of the Potlatch property is vacant with numerous monitoring wells and piezometers that are used for monitoring groundwater.

The Work Plan has been developed pursuant to an Administrative Order on Consent (AOC) agreed to between Potlatch and the U.S. Environmental Protection Agency (EPA). This QAPP is prepared to establish quality procedures for the collection, handling, transport, analytical testing, and data review process for all samples acquired to characterize the Site.

1.3 Site Description

A discussion of the Site is provided in Section 2 of the Work Plan. Site Location figures and maps are included with the Work Plan.

1.4 Sampling Program Design

A detailed description of Site objectives is provided in Section 1.2 of the Work Plan, with the overall intent to provide a range of removal/treatment options, with appropriate analyses of their effectiveness, cost and ability to be implemented in accordance with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Clean Water Act (CWA) requirements for the Site. Sampling locations and frequency, and the sampling procedures and analyses to be performed are presented in the SAP as Attachment B to the Work Plan. The locations of known impact to the Site are described in the text and illustrated on figures of the Work Plan.

2.0 PROJECT ORGANIZATION

2.1 Organizational Structure

The organizational structure for field activities at the Potlatch property is shown graphically in Figure QAPP 1-1. All key project personnel can be reached at the following addresses:

	Golder Project Manager	Golder Field Task Leader	PRP Project Coordinator
Contact:	Mr. Douglas Morell dmorell@golder.com	To Be Determined	Mr. Terry Cundy Terry.Cundy@potlatchcorp.com
Company:	Golder Associates Inc.	Golder Associates Inc.	Potlatch Land and Lumber, LLC
Address:	18300 NE Union Hill Road, Suite 200 Redmond, Washington 98052-3333	1200 W. Ironwood Drive, Coeur d'Alene 99201	530 S. Asbury, Suite 4 Moscow, ID 83848
Phone:	(425) 883-0777 Work	(208) 676-9933 Work Cell (208) 755-3002	208-883-1668 Work Cell 208-301-0410
Facsimile:	(425) 882-5498	(208) 676-8602	N/A

Project Manager

Project Manager, Mr. Douglas Morell, is responsible for planning and coordinating all Golder activities to meet scheduling requirements. Mr. Morell will be involved in day to day discussions with the Potlatch PRP Project Coordinator, and collaboration with the Golder Field Task Leader. He will provide guidance on analytical interpretation, quality assurance efforts, and all report products. He will also provide review for the technical quality, interpretations and conclusions presented in the Removal Report.

Field Task Leader

Field Task Leader, To Be Determined, is responsible for planning and executing all environmental sampling and analysis, for preparation of analytical data reports, preparation of the removal report and all associated Technical Memoranda including submittals to EPA with oversight from the Project Manager. The Field Task Leader prepares the specifications for, and administers the subcontracts for laboratory analysis. The Quality Assurance Coordinator reviews aspects of quality control. Work plan tasks, referenced method quantitation limits, regulatory compliance levels, and other pertinent documents will be reviewed and assessed to determine if data quality objectives are being met.

Health & Safety Officer

Health and Safety Officer, Ms. Jane Mills, C.S.P. is responsible for developing the site Health and Safety Plan (HASP) and communicating the key elements of on-site safety to the field personnel, including personal protective measures and equipment, emergency preparedness, and incident protocol. Due to the remoteness of the Site, Ms. Mills will also ensure adequate communication equipment is available to field personnel for contact in case of field mishaps.

Chemist/Validator

The Chemist/Validator, Mr. Tom Stapp reports to the Project Manager. He is responsible for coordinating with the offsite laboratories to obtain required analyses, and for sample tracking, chain of custody, and other sampling and analysis documentation. The Chemist/Validator maintains the data center files, including tabulating, compiling, and archiving data. The Chemist/Validator is responsible for the review and validation of laboratory analysis reports.

Investigative Field Team

The Investigative Field Personnel report to the Project Manager. Golder's Investigative Field Team To Be Determined and Ms. Bryony Stasney, L.G., L.Hy., Hydrogeologist. These individuals are responsible for collecting all field samples in accordance with the Work Plan, SAP and QAPP. In addition, the Field Personnel are responsible for assembly, organization, and maintenance of all information collected during field activities (including sampling logbook, field parameter records, daily activity logbook, chain-of-custody forms, and water-level measurements).

Golder Remedial Design Team

The principle members of the Golder Remedial Design Team will be lead by Mr. Tim Martin P.E. Design Leader in consultation with Mr. Morell. Golder will also rely on Mr. Lee Holder, P.E., Process Engineer as part of the Golder Environmental Remediation Group to bring innovative ideas towards realizing an effective cleanup action.

2.2 Use of Subcontractors

Golder will use local support contractors as needed for project execution. A surveyor will be selected as needed if additional Site characterization is required, and will be licensed in the State of Idaho for conducting geodetic surveys. Contractors involved in earth moving, push-probe sampling, drilling, or test pit excavation as needed, will also be licensed in the State of Idaho. The subcontracted laboratory, Test America, Inc., is located in Spokane, Washington and conforms to national standards for laboratory accreditation and use of EPA sponsored analytical methodologies. Golder field personnel will ensure the work performed by these subcontractors is in conformance with Golder Technical Procedures.

Subcontractors in the field that may become exposed to Site chemicals must have crew members with current OSHA 40 hour Health and Safety training on-site in substantial compliance with federal regulations. Training certificates for each worker must be maintained on-site during working hours for the duration of the project. Each certificate should have the worker name, date of attendance for the 40 hour training or refresher course, and signature of attending instructor.

Analytical Laboratory

The selection of an appropriate laboratory is based upon the need for data quality, timeliness, and logistics for sample transport and proper handling of samples to meet holding times. The primary laboratory is located near northern Idaho and meets these requirements.

- Test America Analytical Services in Spokane, Washington. (Formerly, North Creek Analytical), will serve as the prime laboratory for certified analysis. Test America / Spokane will facilitate the handling of all samples and may transfer some test requirements to a 'sister' laboratory in Bothell, Washington (Test America / Bothell). Test America holds, as a broad national network of laboratories, current accreditation in the states of Idaho and Washington for petroleum analyses associated with groundwater, drinking water, soils and solid wastes, using a variety of methods. The methods include Washington State Department of Ecology guidance for petroleum hydrocarbons (Ecology, 1997), the EPA SW-846 manual of "Test Methods for Evaluating Solid Wastes" (EPA, 1986), or the Environmental Monitoring Systems Laboratory (EPA, 1994) manual for drinking water tests. Tests for water samples that have potential use as drinking water will be sent to the Test America / Bothell laboratory, since that laboratory currently holds accreditation with the State of Idaho for analysis of drinking water standards for water analytes of concern that are included in Tables QAPP-5 through QAPP-7.

Test America Contact: Ms. Randy Decker (509) 924-9200

Test America, Spokane, Washington

Accreditation Status: Washington State Department of Ecology
Accreditation # C1259 (Laboratory ID)
Expires, January 6, 2010

Test America, Bothell, Washington

Accreditation Status: Idaho State Bureau of Laboratories
Accreditation is approved through the Idaho Department of Health & Welfare (EPA Laboratory ID # WA01217)
Expires, June 30, 2009

- On-Site Environmental, Inc. is a western Washington laboratory, accredited in the State of Washington for analytical methods created by the EPA, Standard Methods, and ASTM, for total petroleum hydrocarbon methods. Their methods are appropriate for groundwater, drinking water, soils and solid wastes. On-Site Environmental will be used as a backup laboratory, for split samples, and for confirmational analysis.

On-Site Environmental Contact: Mr. Blair Goodrow (425) 883-3881

On-Site Environmental, Inc., Redmond, Washington

Accreditation Status: Washington State Department of Ecology
Accreditation # C1309 (Laboratory ID)
Expires, July 26, 2009

3.0 DATA QUALITY OBJECTIVES

3.1 Appropriate Analytical Methods

An objective of the field sampling activities is to provide analytical data that is of known and defensible quality. Tables QAPP-4 through QAPP-7 list all analytical parameters of interest defined for groundwater and soil sampling during the site investigation. The complete list of parameters may include analyses using:

- Northwest Total Petroleum Hydrocarbons for diesel and extended range organics (NWTPH-Dx);
- EPA SW-846 methods for poly-aromatic hydrocarbon compounds (carcinogenic and non-carcinogenic) and naphthalene (EPA 8270C);
- EPA SW-846 methods for metals in soil (EPA 6010C/ 6020A) and groundwater (EPA 200.7/ 200.8). Mercury will be analyzed using EPA 7470A.
- EPA SW-846 methods for polychlorinated biphenyls (PCBs) in soil and water (EPA 8082A).

All well water and surface water samples will have standard field parameters measured including temperature, pH, conductivity, dissolved oxygen, and turbidity.

Petroleum constituents (diesel and heavy oil) will be analyzed using northwest methods for petroleum hydrocarbons (NWTPH-Diesel Extended) (Ecology, 1997). EPA test methods for PAHs, PCBs, and metals are as defined in SW-846 (EPA, 1986) as applicable.

The objectives for analytical data quality are defined in terms of the quantitation limits achievable using the referenced analytical methods, and in terms of the resulting goals for precision, accuracy, representativeness, completeness, and comparability of analytical data. Quantitation limits are provided for each analytical parameter in Tables QAPP-4 through QAPP-7 and are cross-referenced to applicable standard reference methods. The quality objectives established for the EE/CA investigation and monitoring are described as follows:

- **Precision:** Analytical precision shall be reported as required by the governing reference methods cited in Tables QAPP-4 through QAPP-7. At a minimum, data validation criteria for analytical precision will reference the governing methods.
- **Accuracy (Bias):** Accuracy shall be reported as required by the governing reference methods cited in Tables QAPP-4 through QAPP-7. At a minimum, data validation criteria for analytical accuracy will reference the governing methods.
- **Representativeness:** Goals for sample representativeness are addressed qualitatively by the sampling locations and intervals defined in the SAP. In addition, the use of standard procedures for sample acquisition (as described in Section 4 of this QAPP) will facilitate the collection of representative data.
- **Completeness:** Completeness is defined as the percentage of valid analytical determinations with respect to the total number of requested determinations in a given sample delivery group; completeness goals are established at 90 percent. Failure to meet this criterion shall be documented and evaluated in the data validation process described in Section 6 of this QAPP, and corrective action taken as warranted on a case-by-case basis.

- **Comparability:** Approved analytical procedures shall require the consistent use of the reporting techniques and units specified by the reference methods cited in Tables QAPP-4 through QAPP-7 in order to facilitate the comparability of data sets from sequential sampling rounds and from split laboratory submissions in terms of their precision and accuracy.

4.0 SAMPLING AND OTHER FIELD PROCEDURES

4.1 Selected Procedures, by Task

Technical procedures have been developed to support sampling activities, monitoring actions, data validation, and other technical activities. Reference to technical procedures applicable to individual activities, are provided in Table QAPP-1, ('Golder Technical and Quality Procedures List'), and complete copies are kept on file in Golder archives. Field team members have unlimited access to the technical procedures and generate or review copies as needed to maintain the quality steps necessary to complete field activities.

Technical procedures are provided as guidance to technical personnel and as such, require the specific circumstance of application or the knowledge of the field scientist to appropriately apply the guidance criteria. Some technical procedures may have duplicate or similar information provided in other technical procedures that is necessary to be included to provide continuity to the content of the document. Significant changes from the guidance provided in the technical procedures will be identified and documented using procedures in the following section.

4.2 Document Distribution, Variation Request, and Change Control Considerations

The technical procedures and all other procedures cited in this QAPP are subject to the distribution control requirements of Quality Procedure QP-5.1, "Document Preparation, Distribution, and Change Control." Variations from established field procedure requirements may be necessary in response to unique circumstances encountered during sampling activities. All such variations must be documented on a Field Change Request (FCR) form and submitted to the Project Manager for review and approval. A copy of the Field Change Request form is presented in Technical Procedure TP-1.2-23 "Chain of Custody".

The Project Manager or his assigned Field Sampling Personnel are authorized to implement non-substantive variations based on immediate need, provided that the Project Manager is notified within 24 hours of the variation, and the FCR is forwarded to the Project Manager for review within 2 working days. Substantive variations require notification of the Project Manager and Client Project Coordinator before implementation and a FCR is forwarded for review within 2 working days. If the variation is unacceptable to either reviewer, the activity shall be re-performed or other corrective action taken as indicated in the "Comments" section of the FCR. A copy of the FCR shall be included with all field reports, as well as the data validation report. Changes to the requirements of this QAPP or the EE/CA Work Plan shall be controlled through the Interim Change Notice (ICN) procedures as discussed in Section 6.5.2 of QP-5.1.

4.3 Sample Quantities, Types, Locations, and Intervals

Sample quantities, types, locations, and intervals for the groundwater, surface water and soil sampling shall be as specified in the Work Plan and SAP. Field quality control samples shall be included in the minimum quantities specified in Section 7 of this QAPP. Appropriate documentation of the purpose of the sample shall be maintained in the field log, and identified by the assigned sample number; copies of sample identification records shall be separately provided to the data validator. See Section 6 of this QAPP.

4.4 Sample Identification and Labeling Requirements

Sample labels will be attached to each sample container with an assigned field sample identification number applied as each sample is collected during the field activities. The sample identification numbering scheme will be as determined during the field sampling event and will be explained in the field notebook and/ or recorded on the Sample Integrity Data (SIDs) sheets. SIDs shall be completed for all surface water and well water sample collection locations where field parameter data will also be collected. The number system will appear on each sample bottle or container collected and will identify a unique sample identification number applied to one collection sequence for one sample, regardless of the number of bottles and containers collected. The number system will ensure field quality control (QC) samples will remain indistinguishable from the field locations. The label will contain the sampler's initials, one collection date, and one collection time appropriate for each sample, and will be cross referenced by the sample number to identify the location, depth, and monitoring well or geological data in the field notes. An example label is shown below:

<u>GOLDER ASSOCIATES INC.</u>		
<u>(425) 883-0777</u>		
<u>Sample ID #:</u> 06P09-10.5		
<u>Date:</u>		
<u>Time:</u>		
<u>Initials:</u>	<u>Analysis:</u>	<u>Preservative:</u>

Each sample bottle label will also identify the laboratory analysis to be performed, noting the identified method number as stated in Tables QAPP-5, QAPP-6, and QAPP-7 and the preservative added for the appropriate analytical parameter as indicated on the bottle label. Identification numbers shall be recorded in the field notebook, SIDs, and on the chain of custody/sample analysis request form supplied by the analytical laboratory.

4.5 Sample Container Type, Volume, Preservation, and Handling Requirements

All sample containers, container preparation, preservatives, trip blank, and sample storage chests shall be provided by the analytical laboratory as part of their agreement for services. Sample container type, volume requirements, preservation requirements, and special handling requirements are listed by analytical category in Table QAPP-2 for groundwater, and Table QAPP-3 for soil.

All samples shall be sealed, labeled, properly identified, and submitted to the analytical laboratory under formal chain of custody requirements as described in Section 4.6 of this QAPP. Transport sample chests will be secured with a custody seal on the outside, with signature and date provided by the attending field scientist.

4.6 Chain of Custody Considerations

All samples obtained during the course of this investigation shall be controlled as required by procedure TP-1.2-23, "Chain of Custody". Chain of custody forms shall be completed for each shipment of samples as described in the procedure. Chain of Custody forms shall specifically identify the applicable reference methods specified in Tables QAPP-5 through QAPP-7 as appropriate for each individual sample. All laboratory sample tracking procedures shall ensure traceability of analytical results to the original samples through the analytical method referenced on the chain of custody, and the laboratory applied tracking number. The laboratory tracking number will be traceable to unique sample identification numbers as specified in Section 4.4 above.

4.7 Sampling Equipment Decontamination

All non-dedicated sampling equipment (in contact with sample) shall be thoroughly cleaned prior to each sampling event to prevent cross-contamination between samples and to ensure accurate representation of analytes of interest in each sample interval. Non-dedicated equipment shall be cleaned with a brush and non-phosphate detergent, water mixture so that all visible solid matter is removed. A second wash is performed after the detergent/water wash. Steam cleaning may be conducted on excavation equipment used at locations targeted for sampling or down-hole soil sampling equipment in place of hand washing. Sampling tools shall be disassembled or staged as necessary pending their next use. Sampling tools shall be placed in clean, dedicated drums or sealed in clean plastic bags to protect from ambient contamination. Personnel performing decontamination shall wear rubber gloves, face or eye shields, and such other safety equipment as directed by the project-specific HASP.

Should visible matter remain on the non-dedicated equipment after the detergent/water wash, the full complement of wash procedures shall be repeated. If the non-dedicated equipment retains visible matter after the repeated actions, the equipment will be retired from the sampling procedures and not used again. Samplers shall be reassembled using clean rubber gloves; all decontaminated samplers and sampling tools shall be sealed in clean plastic bags pending their next use. All wash and rinse fluids shall be transferred to storage drums for short-term storage on-site, pending characterization and final disposal at the direction of the Project Manager.

4.8 Investigative Derived Wastes (IDW)

Soil cuttings, and borehole residuals may be generated as investigative derived solid waste material that cannot, or otherwise will not be returned to the borehole. Likewise, purge water from well locations will be identified as investigative derived liquid waste (IDW) that must be containerized. The investigative derived waste is the responsibility of the field scientist at the time the IDW is generated. Solid and liquid IDW will be separated and segregated to the extent possible. Solid IDW that can be determined in the field to be non-impacted or minimally impacted, will be sequestered from heavily impacted soils for future designation. Heavily impacted IDW will be containerized. In most cases the IDW will be stored in steel drums (Type 17H) at the site. Each drum shall be labeled by the field scientist, secured with a bolted lid, and placed at the job site in a location where the potential for tampering is minimized. The label requirements will include identification of the contents, the IDW matrix, the date of generation, and a phone number contact for the Golder Project Site manager.

Soil and water samples generated for testing purposes will become the responsibility of the laboratories tasked for the appropriate analyses. As such, all disposal responsibilities will remain with each laboratory at the conclusion of the testing activities for spent samples.

4.9 Calibration Requirements

Calibration of all measuring and test equipment, whether in existing inventory or purchased for this investigation, shall be controlled as required by procedure QP-11.1, "Calibration and Maintenance of Measuring and Test Equipment." Lease equipment shall require certifications or other documentation demonstrating acceptable calibration status for the entire period of use for this project. Field calibration requirements shall be in compliance with the technical procedure describing the instrument's use and/or with the manufacturer's instructions issued with the equipment. Method and analytical equipment-specific calibration requirements applicable within the individual analytical laboratories are addressed by the individual laboratory QA plans or the analytical method.

5.0 ANALYTICAL PROCEDURES

Tables QAPP-4 through QAPP-7 cross-reference the analytes of interest of this investigation to the standard reference methods. Practical quantitation limits (PQLs) for analytes in soils and water samples are given and shall be established as contractual requirements between Golder and the subcontracted analytical laboratory. The subcontracted laboratory is responsible for implementing the analytical methods selected, documenting through Standard Operating Procedures (SOP) modifications (if any) to the methods, and providing these documents for review upon request. Any changes to the method number selected for analysis and identified in Tables QAPP-4 through QAPP-7 must first be brought to the attention of the project manager in writing before analysis can begin.

The contractual requirements for PQLs in soils and water samples are based on potential applicable, relevant, or appropriate requirements (ARARs) established for the site work under State and Federal regulations as indicated in Table QAPP-4 through QAPP-7. PQLs and/or method detection limits (MDLs) in most cases meet the most stringent regulatory screening criteria, which are presented in Tables QAPP-5 through QAPP-7 and Attachment 1 of this document. However, the PQL for thallium can be found “shaded” in Table QAPP-5, since the laboratory PQL exceeds the most stringent ARARs considered for the site. Therefore, since the established method is one of the best available technologies for determination of this analyte, laboratories may be asked to report data below the PQL, and down to the MDL to determine a viable value. As a consequence, this value will be identified as “estimated” in accordance with data validation criteria for analytes that fall below the 99% confidence criteria.

Instances of PQLs found above the most protective cleanup level will be brought to the attention of the Project Manager and analytical results will be assessed by matrix and location at the conclusion of the Remedial Investigation. All other PQLs shall be considered adequate for the removal and remedial actions for soil and water samples.

6.0 DATA REDUCTION, VALIDATION, AND REPORTING

6.1 Minimum Requirements for Laboratory Analytical Data Packages

All analytical data packages submitted by the analytical laboratory shall include the following:

- Sample receipt “condition found” records, noting dates of sample collection, shipment, laboratory receipt, and disposition of sample quality including temperature, breakage, and custody seals.
- Shipping receipt documentation including identification of shipping personnel (or organization).
- Copies of completed chain of custody documentation including communications of field personnel by hand written note, facsimile, or e-mail transmittal.
- Analytical hard copy (paper) summary results for each sample containing neat or dilution adjusted results for all analytes/constituents requested in the chain of custody and request for analysis or purchase order.
- Raw data chromatograms for samples with detected results for all analyses;
- Analytical quality control results and summary documents for laboratory method blanks, laboratory duplicates, laboratory control samples, blank spike/blank spike duplicates, matrix spike/matrix spike duplicates, serial dilutions, quality reference materials, surrogates and internal standards.
- Sample extraction and preparation summary data including dates of sample extraction and analysis and analytical sequence information for each sample set, and each sample dilution and reanalysis.
- Electronic data diskettes or electronic deliverables that provide the summarized results, date of extraction and analysis, quality control data results and true values, client and laboratory sample identifications, analysis methods, dilutions applied and appropriate detection or reporting limits.

All data packages for all analytical parameters shall be reviewed and approved by the analytical laboratory's QA Officer before submittal for validation. If a question arises on a suspect analytical result, CLP equivalent data packages can be obtained from the laboratory after the fact and provided to EPA.

6.2 General Validation Requirements

All analytical data packages from each sample delivery group shall be validated by the detailed review and calculation over-check processes described in “U.S. EPA Contract Laboratory Program National Functional Guidelines for Low Concentration Organic Data Review” (EPA, 2001) and “U.S. EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review” (EPA, 2004). Data validation work will be performed in order to ensure that the laboratory has met all contractual requirements, all applicable reference method requirements, and has met the data quality objectives discussed previously in Section 3 and listed in Tables QAPP-5 through QAPP-7. Validated data will be stored as indicated in procedure TP-2.2-12, "Analytical Data Management" for each sample delivery group. A sample delivery group may be interpreted as a group of 20 samples, or the group of samples delivered to the laboratory in a single sampling event.

The data validator shall document all contacts made with the laboratory to resolve questions related to the data package. The data validator shall complete a data validation checklist applicable for the specified method, documenting the evaluation of holding times, laboratory and field blanks, laboratory and field duplicates, matrix spikes/matrix spike duplicates, laboratory control samples, method calibration data, and any qualification of analytical results required as a consequence of QC deficiencies. The validation checklist, laboratory contact documentation, copies of the laboratory sample summary reports, and the as-reviewed laboratory data package shall be routed to the Project Manager for data assessment purposes and to the permanent project records.

7.0 QUALITY CONTROL PROCEDURES

All analytical samples shall be subject to quality control (QC) measures in both the field and laboratory. The following minimum field quality control requirements apply to all analyses. These requirements are adapted from "Test Methods for Evaluating Solid Waste" (EPA 1986).

- **Field duplicate samples.** Sufficient sample quantities of soil and water for field duplicates will be collected at a frequency of one duplicate per sampling event, or once every 20 samples, whichever is greater. The field duplicates for water samples will be collected from the identical sample stations as stated in the SAP and as close to the original sample collection time as feasible, using identically prepared and preserved containers. Field duplicates will be collected of soil and water samples that are suspected of containing moderate levels of contaminants, based upon field observations. All field duplicates shall be identified with a unique sample identification number and will be analyzed independently as an indication of gross errors in sampling techniques.
- **Field split samples.** Sufficient sample quantities for field splits will be collected at a frequency of one split sample per sampling event, or once every 20 samples, whichever is greater. Field split samples will be collected at locations consistent with the SAP. The field splits for soil will be collected from homogenized composite quantities prepared in the field as stated in the SAP. The field splits for water samples will be collected from the identical sample stations as stated in the SAP and as close to the original sample collection time as feasible. The split samples shall be collected using the same equipment and sampling technique, and shall be placed into identically prepared and preserved containers. The field split samples shall be identified with a unique sample ID number and presented to the subcontract laboratory tasked with confirmation and backup analyses for the purpose of monitoring inter-laboratory precision.
- **Field blanks [Water].** Preparation of field blanks will be required for analyses of water samples. Field blanks for water samples will be established at a frequency of one blank sample per type of equipment being used per sampling event, or once every 20 water samples, whichever is greater. Field blanks for water samples consist of each of the following; 1) pure deionized/ distilled water added to the same batch of clean water sample containers and preservative used in the sampling event as a check on possible contamination originating from container preparation methods, shipment, handling, storage, preservatives or site conditions; and 2) pure deionized/ distilled water washed over non-dedicated equipment used for collection of surface and groundwater samples, as a check on possible carry-over contamination originating from inadequate decontamination of field equipment and field conditions. Field blanks for water samples shall be prepared in the field and submitted to the laboratory as a water sample.
- **Field blanks [Soil].** Preparation of field blanks will be required for non-dedicated field equipment subject to decontamination procedures. Field blanks for field equipment will be established at a frequency of one blank sample per field sampling campaign. Field blanks for field equipment consist of pure deionized/ distilled water rinsed through a piece of equipment that has undergone the decontamination steps as outlined in Section 4.7. The rinse water collected shall be added to the same batch of clean water sample containers and preservative used during the sampling event. Field blanks for field equipment shall be submitted to the laboratory as a water sample. Field blanks for field equipment are used as a check on possible contamination carry-over from field equipment that may not have been properly decontaminated between sample collection stations.

The internal quality control checks performed by the analytical laboratory shall meet the following minimum requirements:

- ***Matrix spike and matrix spike duplicate samples.*** Matrix spike and matrix spike duplicate (MS/MSD) samples require the addition of a known quantity of a representative analyte of interest to soil or water samples as a measure of recovery percentage. The laboratory shall be instructed to select the extra sample material provided with a given sample batch for the purpose of reporting MS/MSD recovery. The substitution of non-project related samples for MS/MSD reporting shall not be allowed to replace the Site specific selection of material for MS/MSD. Spike compound selection, quantities, and concentrations shall be described in the laboratory's analytical procedures. One sample shall be spiked per analytical batch, or once every 20 samples, whichever is greater.
- ***Quality control reference samples (check samples).*** A quality control reference sample (also known as a Laboratory Control Sample; LCS) shall be prepared from an independent standard at a concentration other than that used for calibration, but within the calibration range established for the samples. The quality control reference sample is analyzed after the initial calibration and before any samples are analyzed, and shall be run with every analytical batch, or every 20 samples, whichever is greater. Reference samples are required as an independent check on analytical technique and methodology. Successful LCS recovery shall be maintained within a 90 to 110% acceptance range.
- ***Method blanks.*** Method blanks are prepared during the preparation of both soil and water samples in the laboratory to determine the proficiency of the laboratory at eliminating fugitive vapors, reagent contaminants, and preparation vessel carryover contaminants. The method blank shall be prepared using the same procedure used for preparation of the samples, at the same time, and involving the same reagents. The method blank must be tested after the quality control reference sample and before any samples are analyzed, and shall be run with every analytical batch or 20 samples, whichever is more frequent.

8.0 DATA ASSESSMENT PROCEDURES

As previously discussed in Section 6 of this QAPP, analytical data shall first be compiled by the analytical laboratory, and reduced to include the specified deliverable elements. The data will be validated by project personnel in compliance with existing validation guidelines and submitted to the Project Manager for data assessment, and to the Client. Data assessment will be performed on the distributions and statistical characteristics of the validated data as established in the Work Plan and will consist primarily of comparisons of the data to applicable regulatory levels and historical data to assist in site characterization and completion of the removal report.

9.0 REFERENCES

(Ecology, 1997); *Analytical Methods for Petroleum Hydrocarbons*, Washington State Department of Ecology Toxics Cleanup Program and the Ecology Environmental Laboratory, Publication No. ECY 97-602, June, 1997

(EPA, 1986); *SW-846 Test Methods for Evaluating Solid Waste, Third Edition, Office of Solid Waste and Emergency Response*, USEPA, November, 1986, Rev. May, 1997

(EPA, 2001); *USEPA Contract Laboratory Program National Functional Guidelines for Low Concentration Organic Data Review* (EPA-540/R-00/006) June 2001

(EPA, 2004); *USEPA Contract Laboratory Program Statement of Work for Inorganic Analyses, Multi-media/ Multi-concentration, ILM05.3*, March, 2004.

(EPA, 1994); *Guidance for the Data Quality Objectives Process, EPA QA/G-4*, Office of Research and Development, USEPA, (EPA/600/R-96/055), September 1994

(EPA, 2001); *EPA Guidance for Quality Assurance Project Plans*, EPA QA/R-5, (EPA/240/B-01/003), March, 2001.

(USEPA,1999); *USEPA Contract Laboratory Program Statement of Work for Organics, OLM04.2*, August 1999

(USEPA, 2004); *USEPA Contract Laboratory Program Statement of Work for Inorganic Analyses, Multi-media/ Multi-concentration, ILM05.3*, March, 2004.

TABLES

TABLE QAPP-1

Golder Technical and Quality Procedures List

TP-1.2-5	Drilling, Sampling, and Logging of Soils
TP-1.4-6a	Manual Groundwater Level Measurement
TP-1.2-6	Field Identification of Soil
TP-1.2-12	Monitoring Well Drilling and Installation
TP-1.2-18	Sampling Surface Soil for Chemical Analysis
TP-1.2-20	Collection of Groundwater Quality Samples
TP-1.2-23	Chain of Custody
TP-2.2-12	Analytical Data Management
QP-5.1	Document Preparation, Distribution, and Change Control
QP-10.1	Surveillance Inspection
QP-11.1	Calibration and Maintenance of Measuring and Test Equipment
QP-14.1	Corrective and Preventive Action
QP-16.1	Quality Assurance Records Management

The complete volume of each technical procedure is available from Golder files.

TABLE QAPP-2

Sample Container Types, Volumes, Handling, Preservation, and Holding Times; Groundwater

GROUNDWATER

Analytes	Analytical Method	Container Type	Special Handling	Preservation	Maximum Holding Time
Petroleum Hydrocarbons (Gasoline to Heavy Oil Range Organics)	NWTPH-HCID	1, 1,000 mL narrow mouth amber glass bottles, Teflon-lined cap.	Fill to neck, (Collect an additional 1,000 mL aliquot if Lab QC is to be performed)	HCl, pH <2, store in dark at 4°C.	7 days for extraction, 40 days from date of extraction
Petroleum Hydrocarbons (Diesel Range Organics)	NWTPH-Diesel (extended range)	1, 1,000 mL narrow mouth amber glass bottles, Teflon-lined cap.	Fill to neck, (Collect an additional 1,000 mL aliquot for MS/MSD analysis if required)	HCl, pH <2, store in dark at 4°C.	14 days for analysis
Polychlorinated biphenyl (PCBs) Organic Compounds	EPA 8082A (low level)	2, 1,000 mL narrow mouth amber glass bottles, Teflon-lined cap.	Fill to neck, (Collect additional 2,000 mL aliquot for MS/MSD analysis if required)	None. Store in dark at 4°C.	7 days for extraction, 40 days from date of extraction
Carcinogenic Poly-aromatic Hydrocarbon (C-PAHs; Semi volatile Organic Compounds) and Naphthalene	EPA 8270C	1, 1,000 mL narrow mouth amber glass bottles, lined-lined cap.	Fill to neck, (Collect an additional 1,000 mL aliquot for MS/MSD analysis if required)	None. Store in dark at 4°C.	14 days for extraction, 40 days for analysis after extraction
Metals	EPA 200.7/ 200.8	1, 1,000 ml narrow mouth polymer bottle, with Teflon lined lid.	Fill to neck, (Collect an additional 1,000 mL aliquot for MS/MSD analysis if required)	HNO ₃ , pH <2, store in dark at 4°C.	180 days from sample collection. Mercury is 28 days from collection.
pH, Temperature, Conductivity, Dissolved Oxygen, Turbidity	See Table QAPP-2	Field Parameters; Sample is not collected	Field Parameters; Sample is not collected	Field Parameters; Sample is not collected	Field Parameters; Sample is not collected

TABLE QAPP-3

Sample Container Types, Volumes, Handling, Preservation, and Holding Times;

SOIL

Analytes	Analytical Methods	Container Type	Special Handling	Preservation	Maximum Holding Time
Petroleum Hydrocarbons (Gasoline to Heavy Oil Range Organics)	NWTPH-HCID	1, 4 oz. Wide mouth soil jar	Fill completely	None, store in dark at 4°C.	14 days for extraction, 40 days from date of extraction
Petroleum Hydrocarbons (Diesel Range Organics)	NWTPH-Diesel (extended range)	1, 4 oz. Wide mouth soil jar	Fill completely, (additional 4 oz. aliquot for MS/MSD analysis if required)	None, store in dark at 4°C.	14 days for extraction, 40 days from date of extraction
Polychlorinated biphenyl (PCBs) Organic Compounds	EPA 8082	1, 4 oz. Wide mouth soil jar	Fill completely	None, store in dark at 4°C.	14 days for extraction, 40 days from date of extraction
Carcinogenic Poly-aromatic Hydrocarbon (C-PAHs; Semi volatile Organic Compounds) and Naphthalene	EPA 8270C	1, 4 oz. Wide mouth soil jar	Fill completely, (additional 4 oz. aliquot for MS/MSD analysis if required)	None, store in dark at 4°C.	14 days for extraction, 40 days for analysis after extraction
Metals	EPA 6010C / 6020A	1, 4 oz. Wide mouth soil jar, with Teflon lined lid.	Fill completely. (additional 4 oz. aliquot for MS/MSD analysis if required)	None, store in dark at 4°C.	180 days from sample collection. Mercury is 28 days from collection.

POTLATCH CORPORATION / AVERY LANDING SITE

INORGANIC FIELD PARAMETER
WATER QUALITY CRITERIA

FIELD TESTS	Point of Compliance	Method^a	Target Water PQL	Typical Instrument Applied^c
Temperature	Purge water source	SM2550	0.1 deg. C	Golder Calibrated Mercury Thermometer
pH	Purge water source	EPA 150.1	0.05 units	Orion Model 250Aplus with Combination Glass Electrode.
Specific Conductance	Purge water source	EPA 120.1	5 :mhos	Orion Model 115Aplus with Epoxy 2 Electrode Conductivity Cell.
Turbidity	Purge water source	EPA 180.1	1 NTU	Hach 2100P with dual optical compensation.
Dissolved Oxygen	Purge water source	SM4500-O	0.1 mg/L	Orion Model 810Aplus with Combination Glass Electrode.

Notes:

a - Methods from SW-846, Test Methods for Evaluating Soil Waste (EPA, 1986); Methods for the Chemical Analysis of Water and Wastes (EPA-600/4-79-20; EPA1979); and Standard Methods for the Examination of Water & Wastes (1998, 20th Ed.)

b - PQL: Practical Quantitation Limits established by Manufacturers recommendation.

c - Orion and Hach are registered trademarks.

POTLATCH CORPORATION / AVERY LANDING

PRIORITY POLLUTANT
METALS / CLEANUP LIMITS

Type	Analytes ^a	CAS #	Method ^b	GROUND & SURFACE WATER						SOIL ⁱ
				Laboratory Water PQL ^c	Aquatic Life CMC ^d	Aquatic Life CCC ^e	Idaho DEQ Human Health Quality Criteria ^f ALL WATERS	National Primary Drinking Water Standards ^g	Most Protective Cleanup Level for Groundwater	Laboratory Soil PQL ^c
				ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/Kg
Metals	Aluminum	7429-90-5	6010	20.0	NSA	NSA	NSA	50 h	50	2.5
Metals	Arsenic	7440-38-2	6020	1.0	340	150	50	10	10	1.0
Metals	Antimony	7440-36-0	6020	3.0	NSA	NSA	5.6	6	5.6	2.0
Metals	Beryllium	7440-41-7	6020	0.5	NSA	NSA	NSA	4	4	0.50
Metals	Cadmium	7440-43-9	6020	0.5	1.3	0.6	NSA	5	0.6	0.50
Metals	Chromium	7440-47-3	6020	1.0	570	74	NSA	100	74	0.50
Metals	Copper	7440-50-8	6020	1.0	17	11	NSA	1300	11	1.0
Metals	Lead	7439-92-1	6020	0.5	65	2.5	NSA	15	2.5	5.0
Metals	Iron	7439-89-6	6010	20.0	NSA	NSA	NSA	300h	300	1.0
Metals	Manganese	7439-96-5	6010	10.0	NSA	NSA	NSA	50	50	0.5
Metals	Mercury	7439-97-6	7470A	0.20	g	g	NSA	2	2	0.02
Metals	Nickel	7440-02-0	6020	1.0	470	52	610	NSA	52	1.0
Metals	Selenium	7782-49-2	6020	3.0	20	5.0	170	50	5	2.0
Metals	Silver	7440-22-4	6020	0.5	3.4	NSA	NSA	100 h	3.4	0.50
Metals	Thallium	7440-30-4	6020	1.0	NSA	NSA	0.24	2	0.24	0.50
Metals	Zinc	7440-66-6	6020	10.0	120	120	7400	5000 h	120	3.0
Notes:										
NA - Not applicable.										
NSA - No standard available.										
Standard PQL is above lowest potential cleanup criteria. Alternate analytical methods may be employed.										
a - Priority Pollutant metals list.										
b - SW846 analytical method 6020 (ICP/MS).										
c - PQL; Practical Quantitation Limit established by the laboratory.										
From Idaho Administrative Code; IDAPA 58.01.02, 210.01 Department of Environmental Quality, Water Quality Standards;										
d - Acute Criterion Maximum Concentration (CMC) for numeric cleanup criteria.										
e - Chronic Criterion Maximum Concentration (CCC) for numeric cleanup criteria.										
f - Numeric Criteria for Toxic Substances for Waters Designated for Aquatic Life, Recreation, or Domestic Water Supply Use;										
g - Federal Water Quality Criteria, Primary Drinking Water Standards, Maximum Contaminant Levels (MCLs).										
h - Federal Water Quality Criteria, Secondary Drinking Water Standards.										
i - See Attachment 1 for sediment and soil screening criteria.										

POTLATCH CORPORATION / AVERY LANDING SITE

POLYAROMATIC HYDROCARBON / PETROLEUM CLEANUP LIMITS

Type	CAS #	Analytes ^a	Method ^b	WATER		SOIL ^g	
				Laboratory WATER PQL ^c	IDTL ^d for Groundwater	Laboratory SOIL PQL ^c	IDTL ^d for Soil
				mg/L	mg/L	mg/Kg	mg/Kg
Carcinogen	56-55-3	Benzo(a)anthracene	8270C	0.01	0.0001	0.013	0.422
	50-32-8	Benzo(a)pyrene	8270C	0.01	0.0002e	0.013	0.042
	205-99-2	Benzo(b)fluoranthene	8270C	0.01	0.0001	0.013	0.422
	207-08-9	Benzo(k)fluoranthene	8270C	0.01	0.0008	0.013	4.22
	218-01-9	Chrysene	8270C	0.01	0.008	0.013	15 f
	53-70-3	Dibenzo(a,h)anthracene	8270C	0.01	0.00001	0.013	0.042
	193-39-5	Indeno(1,2,3-cd)pyrene	8270C	0.01	0.0001	0.013	0.422
Non-Carcinogen	83-32-9	Acenaphthene	8270C	0.1	0.63	0.013	3400 f
	208-96-8	Acenaphthylene	8270C	0.1	0.63	0.013	NSA
	120-12-7	Anthracene	8270C	0.1	3.13	0.013	17000 f
	206-44-0	Fluoranthene	8270C	0.01	0.42	0.013	2300 f
	86-73-7	Fluorene	8270C	0.1	0.42	0.013	2300 f
	91-20-3	Naphthalene	8270C	0.01	0.21	0.013	1.14
	85-01-8	Phenanthrene	8270C	0.1	0.31	0.013	NSA
	129-00-0	Pyrene	8270C	0.1	0.31	0.013	1700 f
	191-24-2	Benzo(g,h,i)perylene	8270C	0.1	0.31	0.013	1177.98
Petroleum	-	Diesel Range Organics ^{aa}	NWTPH-Dx	0.25	NSA	25	NSA
Petroleum	-	Heavy Oils	NWTPH-Dx	0.5	NSA	50	NSA
Petroleum	-	Mineral Oil	NWTPH-Dx	0.5	NSA	50	NSA
NOTES: a - Analyte list is from Multi-Media, Multi-Concentration Organic Analytical Statement of Work (OLM04.3) aa - Petroleum listed compounds are not regulated materials in the State of Idaho, however WA State Ecology analytical methods as presented will be used for characterization, using the indicated PQLs. b - SW846 analytical method. c - Practical Quantitation Limit (PQL), established by laboratory. d - Initial Default Target Levels (IDTL). e - Federal Water Quality Primary Drinking Water Standard, Maximum contaminant level (MCLs). f - Region 9 Preliminary Remediation Goals (PRGs) for Residential scenarios. g - See Attachment 1 for additional sediment and soil screening criteria. NA Not applicable. NSA No standard available.							

POLYCHLORINATED BIPHENYL (PCBs) CLEANUP LIMITS

Type	Analytes	CAS #	Method ^a	WATER				SOIL ^f		
				Laboratory Water PQL / MDL ^b	Federal Primary Drinking Water MCLs ^c	Idaho Initial Default Target Levels (IDTL)	Most Protective Cleanup Level for Groundwater ^e	Laboratory Soil PQL / MDL ^b	Idaho Initial Default Target Levels (IDTL)	Most Protective Cleanup Level for Soil ^e
				ug/L	ug/L	ug/L	ug/L	mg/Kg	mg/Kg	mg/Kg
PCBs	Aroclor 1016	12674-11-2	8082	0.1 / 0.053	0.1	0.730	0.1	0.05 / 0.0049	2.3343	2.3343
PCBs	Aroclor 1221	11104-28-2	8082	0.1 / 0.0391	0.1	0.028	0.028	0.05 / 0.0099	0.0029	0.0029
PCBs	Aroclor 1232	11141-16-5	8082	0.1 / 0.0106	0.1	NSA	0.1	0.05 / 0.0099	NSA	NSA
PCBs	Aroclor 1242	53469-21-9	8082	0.1 / 0.0133	0.1	0.028	0.028	0.05 / 0.0099	0.0032	0.0032
PCBs	Aroclor 1248	12672-29-6	8082	0.1 / 0.0082	0.1	0.028	0.028	0.05 / 0.0099	0.1374	0.1374
PCBs	Aroclor 1254	11097-69-1	8082	0.1 / 0.07	0.1	0.209	0.1	0.05 / 0.0072	0.7400	0.7400
PCBs	Aroclor 1260	11096-82-5	8082	0.1 / 0.014	0.1	0.028	0.028	0.05 / 0.0041	0.1466	0.1466
Notes: NSA - No standard available. Standard PQL or MDL is above lowest potential cleanup criteria. a - SW846 analytical methods. b - PQL / MDL; Practical Quantitation Limit and Method Detection Limit respectively, established by the laboratory. c - National Primary Drinking Water Quality Standard, Maximum Contaminant Levels (MCL), total mixture amount. [40 CFR 141.50]. d - Idaho Initial Default Target Levels, from Idaho Risk Evaluation Manual, FINAL; Version July, 2004. e - Shaded cells reflect data limits that are not met by the stated Laboratory PQL. f - See Attachment 1 for additional sediment and soil screening criteria.										

FIGURE

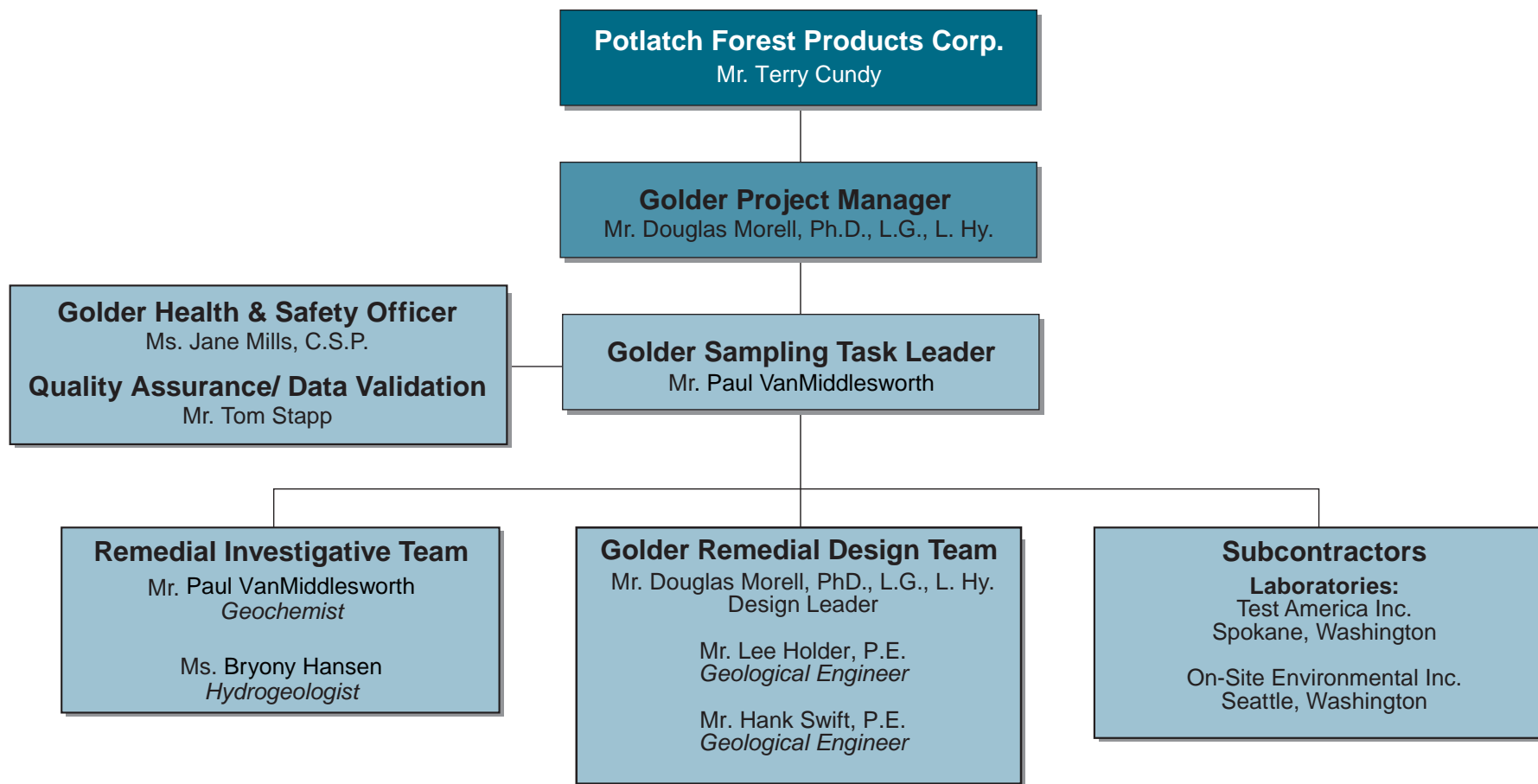


FIGURE **QAPP1-1**
GOLDER PROJECT ORGANIZATION
DENOVO/TRIUMPH SITE PH1 ESA/ID

ATTACHMENT 1

REGULATORY SCREENING LEVEL CRITERIA

EPA Region III BTAG
 Freshwater Sediment Screening Benchmarks
 8/2006

CAS#	Analyte	FW Sed (mg/kg)	Ref	End Note	Bioaccumulative ⁹	
					Class of Compound	
71-55-6	1,1,1-Trichloroethane	0.0302	a,b	1	Volatile	
79-34-5	1,1,2,2-Tetrachloroethane	1.36	a,b	1	Volatile	
127-18-4	1,1,2,2-Tetrachloroethylene (PCE)	0.468	a,b	1	Volatile	
79-00-5	1,1,2-Trichloroethane	1.24	a,b	1	Volatile	
79-01-6	1,1,2-Trichloroethene (TCE)	0.0969	a,b	1		
92-52-4	1,1-Biphenyl	1.22	a,b	1	PAH	
75-35-4	1,1-Dichloroethene (1,1-Dichloroethylene)	0.031	a,b	1	Volatile	
75-35-4	1,1-Dichloroethylene	0.031	a,b	1	Volatile	
634-66-2	1,2,3,4-Tetrachlorobenzene	0.702	a,b	1	Other Semi-Volatile	B
87-61-6	1,2,3-Trichlorobenzene	0.858	a,b	1	Other Semi-Volatile	
95-94-3	1,2,4,5-Tetrachlorobenzene	1.09	a,b	1	Other Semi-Volatile	B
120-82-1	1,2,4-Trichlorobenzene	2.1	a,b	1	Volatile	B
95-63-6	1,2,4-Trimethylbenzene				Volatile	B
95-50-1	1,2-Dichlorobenzene	0.0165	a,b	1	Volatile	B
156-60-5	1,2-Trans-Dichloroethylene	1.05	a,b	1	Volatile	
541-73-1	1,3-Dichlorobenzene	4.43	a,b	1	Volatile	B
542-75-6	1,3-Dichloropropene (1,3-Dichloropropylene)	0.0000509	a,b	1	Volatile	
542-75-6	1,3-Dichloropropylene	0.0000509	a,b	1	Volatile	
106-46-7	1,4-Dichlorobenzene	0.599	a,b	1	Volatile	B
99-99-0	1-Methyl-4-nitrobenzene (4-Nitrotoluene)	4.06	a,b	1	Other Semi-Volatile	
58-90-2	2,3,4,6-Tetrachlorophenol	0.284	a,b	1	Other Semi-Volatile	
1746-01-6	2,3,7,8-TCDD-Dioxin	0.00000085	c,d		Dioxin/Furans	B
51207-31-9	2,3,7,8-TCDF		d	2	Dioxin/Furans	B
93-72-1	2,4,5-TP (Silvex)	0.675	a,b	1	Volatile	
93-76-5	2,4,5-Trichlorophenoxyacetic acid	12.3	a,b	1	Phenoxyaceticacid Herbicide	
88-06-2	2,4,6-Trichlorophenol	0.213	a,b	1	Other Semi-Volatile	
118-96-7	2,4,6-Trinitrotoluene (TNT)	0.092	e		Other Semi-Volatile	
120-83-2	2,4-Dichlorophenol	0.117	a,b	1	Other Semi-Volatile	
105-67-9	2,4-Dimethylphenol	0.029	f	3	Other Semi-Volatile	
121-14-2	2,4-Dinitrotoluene	0.0416	a,b	1	Other Semi-Volatile	
95-57-8	2-Chlorophenol	0.0312	a,b	1	Other Semi-Volatile	
91-57-6	2-Methylnaphthalene	0.0202	c		PAH	
91-94-1	3,3'- Dichlorobenzidine	0.127	a,b	1	Other Semi-Volatile	
101-55-3	4-Bromophenyl phenyl ether	1.23	a,b	1	Other Semi-Volatile	B
7005-72-3	4-Chlorophenyl- phenyl ether				Other Semi-Volatile	B
106-44-5	4-Methylphenol	0.67	f	3	Other Semi-Volatile	
99-99-0	4-Nitrotoluene	4.06	a,b	1	Other Semi-Volatile	
83-32-9	Acenaphthene	0.0067	c		PAH	B
208-96-8	Acenaphthylene	0.0059	c		PAH	B
309-00-2	Aldrin	0.002	g	4	Organochlorine Pesticide	B
120-12-7	Anthracene	0.0572	h		PAH	B
7440-36-0	Antimony	2	i	5	Inorganic/Metal	
12674-11-2	Aroclor 1016 (PCBs, total)				Other Pesticide/PCB	B
11104-28-2	Aroclor 1221 (PCBs, total)				Other Pesticide/PCB	B
11141-16-5	Aroclor 1232 (PCBs, total)				Other Pesticide/PCB	B
53469-21-9	Aroclor 1242 (PCBs, total)				Other Pesticide/PCB	B
12672-29-6	Aroclor 1248 (PCBs, total)				Other Pesticide/PCB	B
11097-69-1	Aroclor 1254 (PCBs, total)				Other Pesticide/PCB	B
11096-82-5	Aroclor 1260 (PCBs, total)				Other Pesticide/PCB	B
7440-38-2	Arsenic	9.8	h		Inorganic/Metal	B

EPA Region III BTAG
 Freshwater Sediment Screening Benchmarks
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CAS#	Analyte	FW Sed (mg/kg)	Ref	End Note	Bioaccumulative ⁹	
					Class of Compound	
1912-24-9	Atrazine	0.00662	a,b	1	Triazine Herbicide	
86-50-0	Azinophosmethyl (Guthion)	0.0000505	a,b	1	Organophosphorus Pesticide	
56-55-3	Benzo(a)anthracene	0.108	h		PAH	B
50-32-8	Benzo(a)pyrene	0.15	h		PAH	B
	Benzo(b+k)fluoranthene	0.0272	j		PAH	B
191-24-2	Benzo(g,h,i)perylene	0.17	g		PAH	B
207-08-9	Benzo(k)fluoranthene	0.24	g		PAH	B
65-85-0	Benzoic Acid	0.65	f	3	Other Semi-Volatile	
319-84-6	BHC, alpha	0.006	g		Organochlorine Pesticide	B
319-85-7	BHC, beta	0.005	g		Organochlorine Pesticide	B
319-86-8	BHC, delta	6.4	a,b	1	Organochlorine Pesticide	B
58-89-9	BHC, gamma (Lindane)	0.00237	h		Organochlorine Pesticide	B
92-52-4	Biphenyl (1,1-Biphenyl)	1.22	a,b	1	Other Semi-Volatile	
117-81-7	bis (2-ethylhexyl) phthalate	0.18	k		Other Semi-Volatile	
75-25-2	Bromoform	0.654	a,b	1	Volatile	
85-68-7	Butyl benzyl phthalate	10.9	a,b	1	Other Semi-Volatile	
7440-43-9	Cadmium	0.99	h	6	Inorganic/Metal	B
63-25-2	Carbaryl (Sevin)	0.000418	a,b	1	Other Pesticide/PCB	
1563-66-2	Carbofuran	0.00344	a,b	1	N-Methylcarbamate Herbicide	
75-15-0	Carbon disulfide	0.000851	a,b	1	Volatile	
56-23-5	Carbon tetrachloride	0.0642	a,b	1	Volatile	
57-74-9	Chlordane	0.00324	h		Organochlorine Pesticide	B
108-90-7	Chlorobenzene	0.00842	a,b	1	Volatile	
510-15-6	Chlorobenzilate	1.45	a,b	1	Other Pesticide/PCB	
2921-88-2	Chloropyrifos	0.00519	a,b	1	Organophosphorus Pesticide	B
7440-47-3	Chromium	43.4	h	6	Inorganic/Metal	
218-01-9	Chrysene	0.166	h		PAH	B
156-59-2	cis-1,2-Dichloroethene (cis-1,2-Dichloroethylene)				Volatile	B
156-59-2	cis-1,2-Dichloroethylene				Volatile	B
7440-48-4	Cobalt	50	g	4	Inorganic/Metal	
7440-50-8	Copper	31.6	h	6	Inorganic/Metal	B
98-82-8	Cumene	0.086	a,b	1	Volatile	
	Cyanide, complex, total				Inorganic/Metal	
57-12-5	Cyanide, free	0.1	g	4	Inorganic/Metal	
72-54-8	DDD (p,p')	0.00488	h		Organochlorine Pesticide	B
72-55-9	DDE	0.00316	h		Organochlorine Pesticide	B
	DDT, total	0.00416	h		Organochlorine Pesticide	B
	DDT/DDE/DDD, total	0.00528	h		Organochlorine Pesticide	B
333-41-5	Diazinon	0.00239	a,b	1	Other Pesticide/PCB	B
53-70-3	Dibenzo(a,h)anthracene	0.033	h		PAH	B
132-64-9	Dibenzofuran	0.415	a,b	1	Other Semi-Volatile	
542-75-6	Dichloropropene (1,3-Dichloropropylene)	0.0000509	a,b	1	Volatile	
115-32-2	Dicofol (Kelthane)				Other Pesticide/PCB	B
60-57-1	Dieldrin	0.0019	h		Organochlorine Pesticide	B
84-66-2	Diethylphthalate	0.603	a,b	1	Other Semi-Volatile	
84-74-2	Di-n-butyl phthalate	6.47	a,b	1	Other Semi-Volatile	
88-85-7	Dinoseb	0.000611	a,b	1	Other Pesticide/PCB	
298-04-4	Disulfoton				Pesticide	B
115-29-7	Endosulfan (alpha and beta)	0.00214	a,b	1	Organochlorine Pesticide	B

EPA Region III BTAG
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CAS#	Analyte	FW Sed (mg/kg)	Ref	End Note	Bioaccumulative ⁹	
					Class of Compound	
959-98-8	Endosulfan I (a-endosulfan)	0.0029	I		Organochlorine Pesticide	B
33213-65-9	Endosulfan II (b-endosulfan)	0.014	I		Organochlorine Pesticide	B
1031-07-8	Endosulfan sulfate	0.0054	I	7	Organochlorine Pesticide	
72-20-8	Endrin	0.00222	h		Organochlorine Pesticide	B
100-41-4	Ethylbenzene	1.1	a,b	1	Volatile	
206-44-0	Fluoranthene	0.423	h		PAH	B
86-73-7	Fluorene	0.0774	h		PAH	B
86-50-0	Guthion	0.0000505	a,b	1	Other Pesticide/PCB	
319-84-6	HCH, a- (BHC, alpha)	0.006	g		Organochlorine Pesticide	
319-85-7	HCH, b- (BHC, beta)	0.005	g		Organochlorine Pesticide	
319-86-8	HCH, d- (BHC, delta)	6.4	a,b	1	Organochlorine Pesticide	
58-89-9	HCH, gamma (Lindane) (BHC, gamma)	0.00237	h		Organochlorine Pesticide	
76-44-8	Heptachlor	0.068	f	8	Organochlorine Pesticide	B
1024-57-3	Heptachlor epoxide	0.00247	h		Organochlorine Pesticide	B
118-74-1	Hexachlorobenzene	0.02	g	4	Other Semi-Volatile	B
87-68-3	Hexachlorobutadiene				Volatile	B
608-73-1	Hexachlorocyclohexanes (HCH, BHC)	0.003	g	4	Organochlorine Pesticide	B
77-47-4	Hexachlorocyclopentadiene				Organochlorine Pesticide	B
67-72-1	Hexachloroethane	1.027	a,b	1	Volatile	B
110-54-3	Hexane	0.0396	a,b	1	Volatile	
193-39-5	Indeno(1,2,3-c,d)pyrene	0.017	j	9	PAH	B
7439-89-6	Iron	20000	g		Inorganic/Metal	
98-82-8	Isopropylbenzene (Cumene)	0.086	a,b	1		
7439-92-1	Lead	35.8	h	6	Inorganic/Metal	B
58-89-9	Lindane (BHC,gamma)	0.00237	h		Organochlorine Pesticide	
121-75-5	Malathion	0.000203	a,b	1	Other Pesticide/PCB	
7439-96-5	Manganese	460	g	4	Inorganic/Metal	
7439-97-6	Mercury	0.18	h		Inorganic/Metal	
72-43-5	Methoxychlor	0.0187	a,b	1	Organochlorine Pesticide	B
22967-92-6	Methylmercury				Volatile	B
2385-85-5	Mirex	0.007	g	4	Chlorinated Pesticides	B
108-90-7	Monochlorobenzene (Chlorobenzene)	0.00842	a,b	1		
91-20-3	Naphthalene	0.176	h		PAH	
84-74-2	n-Butylphthalate (Di-n-butyl phthalate)	6.47	a,b	1	Other Semi-Volatile	
7440-02-0	Nickel	22.7	h	6	Inorganic/Metal	B
86-30-6	N-Nitrosodiphenylamine	2.68	a,b	1	Other Semi-Volatile	
	PAHs, High Molecular Weight	0.19	j	9	PAH	
	PAHs, Low Molecular Weight	0.076	j		PAH	
SEQ NO-27-3	PAHs, total	1.61	h	10	PAH	
56-38-2	Parathion	0.000757	a,b	1	PAH	
1336-36-3	PCBs, total	0.0598	h	2	Other Pesticide/PCB	B
106-44-5	p-Cresol (4-Methylphenol)	0.67	f	3	Other Semi-Volatile	
608-93-5	Pentachlorobenzene	8.89	a,b	1	Other Semi-Volatile	B
76-01-7	Pentachloroethane	0.826	a,b	1	Other Semi-Volatile	
82-68-8	Pentachloronitrobenzene				Pesticide	B
87-86-5	Pentachlorophenol	0.504	a,b	1	Other Semi-Volatile	B
85-01-8	Phenanthrene	0.204	h		PAH	B
108-95-2	Phenol	0.42	f	3	Other Semi-Volatile	B
100-42-5	Phenylethylene	0.559	a,b	1	Other Semi-Volatile	

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CAS#	Analyte	FW Sed (mg/kg)	Ref	End Note	Bioaccumulative ⁹	
					Class of Compound	
298-02-2	Phorate	0.201	a,b	1		
51207-31-9	Polychlorinated dibenzofurans		d	2	Dioxins/Furans	
	Polychlorinated dibenzo-p-dioxins (PCDDs)		d	2	Dioxins/Furans	
129-00-0	Pyrene	0.195	h		PAH	B
121-82-4	RDX (Cyclonite)	0.013	e		Explosive	
7782-49-2	Selenium	2	m		Inorganic/Metal	B
7440-22-4	Silver	1.0	i	5,6	Inorganic/Metal	B
100-42-5	Styrene (Phenylethylene)	0.559	a,b	1	Volatile	
18946-25-8	Sulfides	130	n	11	Anion	
95-94-3	Tetrachlorobenzene (1,2,4,5-Tetrachlorobenzene)	1.09	a,b	1	Other Semi-Volatile	
79-34-5	Tetrachloroethane (1,1,2,2-Tetrachloroethane)	1.36	a,b	1	Volatile	
127-18-4	Tetrachloroethene (1,1,2,2-Tetrachloroethylene)	0.468	a,b	1	Volatile	
127-18-4	Tetrachloroethylene (1,1,2,2-Tetrachloroethylene)	0.468	a,b	1	Volatile	
56-23-5	Tetrachloromethane (Carbon tetrachloride)	0.0642	a,b	1	Volatile	
8001-35-2	Toxaphene	0.0001	c		Organochlorine Pesticide	B
156-60-5	trans-1,2-Dichloroethylene (1,2-trans-Dichloroethylene)	1.05	a,b	1	Volatile	
75-25-2	Tribromomethane (Bromoform)	0.654	a,b	1	Volatile	
688-73-3	Tributyltin				Inorganic/Metal	B
79-00-5	Trichloroethane (1,1,2-Trichloroethane)	1.24	a,b	1	Volatile	
79-01-6	Trichloroethene (Trichloroethylene)	0.0969	a,b	1	Volatile	
79-01-6	Trichloroethylene	0.0969	a,b	1	Volatile	
1582-09-8	Trifluralin	0.355	a,b	1		
100-42-5	Vinyl benzene (Phenylethylene)	0.559	a,b	1	Volatile	
75-35-4	Vinylidene chloride (1,1-Dichloroethylene)	0.031	a,b	1	Volatile	
108-38-3	Xylene, m-	0.0252	a,b	1	Volatile	
7440-66-6	Zinc	121	h	6	Inorganic/Metal	B

EPA Region III BTAG
FRESHWATER SEDIMENT SCREENING BENCHMARKS
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LITERATURE CITED

^aRegion III BTAG Freshwater Screening Benchmarks. 2004. <http://www.epa.gov/reg3hwm/risk/eco/btag/sbv/fw/screenbench.htm>

^bKarickhoff, S.W. and J.M. Long. Environmental Research Laboratory. U.S. EPA. 1995. Internal Report on Summary of Measured, Calculated and Recommended Log K_{ow} Values.

^cCCME (Canadian Council of Ministers of the Environment). 2003. Canadian Environmental Quality Guidelines: Summary Table December 2003. Canadian Council of Ministers of the Environment, Winnipeg, Manitoba. Available at http://www.ccme.ca/publications/cegg_rcqe.html

^dVan den Berg, M., Birnbaum, L., Bosveld, A.T.C., Brunstrom, B., Cook, P., Feeley, M., Giesy, J.P., Hanberg, A., Hasegawa, R., Kennedy, S.W., Kubiak, T., Larsen, J.C., Rolaf van Leeuwen, F.X., Liem, A.K.D., Nolt, C., Peterson, R.E., Poellinger, L., Safe, S., Schrenk, D., Tillitt, D., Tysklind, M., Younes, M., Waern, F., and Zacharewski, T. 1998. Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environmental Health Perspectives. 106 (12): 775-792. Available at: <http://ehp.niehs.nih.gov/members/1998/106p775-792vandenbergvandenberg-full.html>

^eTalmage, S.S., D.M. Opresko, C.J. Maxwell, J.E. Welsh, M. Cretella, P.H. Reno, and F.B. Daniel. 1999. Nitroaromatic munition compounds: Environmental effects and screening values. Reviews in Environmental Contamination and Toxicology. 161: 1-156

^fJones, D.S., G.W. Suter II and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 Revision. ES/ER/TM-95/R4. Oak Ridge National Laboratory, Oak Ridge, TN. Available at: <http://www.esd.ornl.gov/programs/ecorisk/documents/tm95r4.pdf>

^gPersaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of the Environment. Queen's Printer of Ontario. Available at: <http://www.ene.gov.on.ca/envision/gp/B1-3.pdf>

^hMacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39: 20-31.

ⁱLong, E.R. and L.G. Morgan. 1990. The potential for biological effects of sediment-sorbed contaminants tested in the national status and trends program. NOAA Technical Memorandum NOS OMA 52.

^jIngersoll, C.G., P.S. Haverland, E.L. Brunson, T.J. Canfield, F.J. Dwyer, C.E. Henke, N.E. Kemble, D.R. Mount, and R.G. Fox. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod *Hyalella azteca* and the midge *Chironomus riparius*. International Association of Great Lakes Research. 22:602-623.

^kMacDonald, D.D., C.G. Ingersoll, D.E. Smrong, R.A. Lindscoog, G. Sloane, T. Biernacki. 2003. Development and evaluation of numerical sediment quality assessment guidelines for Florida inland waters. Florida Department of Environmental Protection. Available at: http://www.dep.state.fl.us/water/monitoring/docs/seds/SQAGs_for_Florida_Inland_Waters_01_03.PDF

^lU.S. EPA. 1996. Eco Update: Ecotox Thresholds. Office of Solid Waste and Emergency Response. Washington, D.C. EPA 540/F 95/038. Available at: http://www.epa.gov/oswer/riskassessment/pdf/eco_updt.pdf

^mLemley, A.D. 2002. Selenium assessment in aquatic ecosystems. US Forest Service, Blacksburg, VA.

ⁿBuchman, M.F. 1999. NOAA Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Seattle, WA, Coastal Protection and Restoration Division, National Oceanic Atmospheric Administration. Available at:
http://response.restoration.noaa.gov/book_shelf/122_squirt_cards.pdf

^oU.S. EPA. 2000. Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment. Available at:
<http://www.epa.gov/waterscience/cs/biotesting/bioaccum.pdf>

ENDNOTES

¹Value derived from the EqP method with Region III BTAG freshwater values (2004^a) and logKow values from Karickhoff and Long (1995^b). Only logKow values between 2 and 6 were used, as suggested by the EPA (2000^o).

²Congener- and receptor-specific dioxin equivalency.

³Apparent Effects Threshold (AET) marine value from Washington State Sediment Quality Standards as cited by Jones et al. (1997^f).

⁴Lowest Effect Level (LEL).

⁵Effect Range Lows (ERL), equivalent to the lower 10th percentile of the analyzed data in Long and Morgan (1990^j).

⁶ EPA has published Equilibrium Partitioning Sediment Benchmarks (ESB) for metal mixtures including this metal. Implementation of the ESB requires metal concentration data based on the simultaneously extracted metals procedure (SEM) and measurement of the acid volatile sulfide (AVS) concentration during the period from November to May. Application of ESB benefits significantly from the quantification of the organic carbon. BTAG recommends that these metals be screened against listed benchmarks in the screening level ecological risk assessment. Any exceedances should be further evaluated using ESBs following the sampling and analysis guidance in EPA-600-R-02-011 in Step 3 of the baseline ecological risk assessment.

⁷EqP value calculated using GLWQI Tier II and listed in source document (U.S. EPA 1996^l) as "Endosulfan, mixed isomers."

⁸EqP value calculated using Tier II Secondary Chronic Value from Suter and Tsao (1996). Heptachlor LogKow 6.10 from Syracuse Research Corporation.

⁹ARCs TEL (Assessment and Remediation of Contaminated Sediments Program Threshold Effects Level – 28d test using *Hyallela azteca* from U.S. EPA (1996ⁿ).

¹⁰EPA has established an equilibrium partitioning (EqP) approach for PAH mixtures in sediments (EPA-600-R-02-013), which may be used as an alternative or in comparison to this empirical screening value. Use of the EqP $\Sigma\text{ESBTU}_{\text{FCV}}$ as a screening value requires that the PAH analyses include all 34 parent and daughter parameters (i.e., generic correction factors are not applicable). Alternatively, a site-specific correction factor based on 20% of the samples having 34 parameters may be applied for datasets where $n \geq 30$.

¹¹Lowest reliable value among AET (Apparent Effects Threshold) tests: Microtox (Buchman 1999ⁿ)

INITIAL DEFAULT TARGET LEVELS (IDTL)

CHEMICALS OF CONCERN	SOIL			GROUNDWATER		
	IDTL [mg/kg]	Critical Pathway	Critical Receptor	IDTL [mg/L]	Critical Pathway	Critical Receptor
1,1,1,2-Tetrachloroethane	4.09E-02	GWP ^a	GWP	2.15E-03	Ingestion	Risk-Based
1,1,1-Trichloroethane	2.00E+00	GWP	GWP	2.00E-01	Ingestion	MCL ^b
1,1,2,2-Tetrachloroethane	9.15E-04	GWP	GWP	2.79E-04	Ingestion	Risk-Based
1,1,2-Trichloroethane	1.41E-02	GWP	GWP	5.00E-03	Ingestion	MCL
1,1-Dichloroethane	3.48E+00	GWP	GWP	1.04E+00	Ingestion	Risk-Based
1,1-Dichloroethene	3.88E-02	GWP	GWP	7.00E-03	Ingestion	MCL
1,2,3-Trichloropropane	2.45E-04	GWP	GWP	2.79E-05	Ingestion	Risk-Based
1,2,4-Trichlorobenzene	6.92E-01	Subsurface Soil	Child	7.00E-02	Ingestion	MCL
1,2,4-Trimethylbenzene (pseudocumene)	1.93E-01	Subsurface Soil	Child	4.39E-01	Indoor Inhalation	Child
1,2-Dibromo-3-chloropropane	9.75E-04	GWP	GWP	2.00E-04	Ingestion	MCL
1,2-Dichlorobenzene	5.25E+00	GWP	GWP	6.00E-01	Ingestion	MCL
1,2-Dichloroethane	7.67E-03	Subsurface Soil	Child	5.00E-03	Ingestion	MCL
1,2-Dichloroethene-(cis)	1.93E-01	GWP	GWP	7.00E-02	Ingestion	MCL
1,2-Dichloroethene-(trans)	3.65E-01	GWP	GWP	1.00E-01	Ingestion	MCL
1,2-Dichloropropane	8.90E-03	Subsurface Soil	Child	5.00E-03	Ingestion	MCL
1,2-Diphenylhydrazine	9.48E-04	GWP	GWP	6.98E-05	Ingestion	Risk-Based
1,3,5-Trimethylbenzene	1.45E-01	Subsurface Soil	Child	3.04E-01	Indoor Inhalation	Child
1,3-Dichlorobenzene	2.29E-01	Subsurface Soil	Child	9.39E-03	Ingestion	Risk-Based
1,3-Dichloropropene-(cis)	2.45E-03	GWP	GWP	5.59E-04	Ingestion	Risk-Based
1,3-Dichloropropene-(trans)	2.45E-03	GWP	GWP	5.59E-04	Ingestion	Risk-Based
1,4-Dichlorobenzene	7.55E-02	Subsurface Soil	Child	7.50E-02	Ingestion	MCL
2,3,7,8-TCDD ^h	3.91E-06	Surficial Soil	Age-Adjusted	3.00E-08	Ingestion	MCL
2,4,5 TP (silvex) ⁱ	2.37E+00	GWP	GWP	5.00E-02	Ingestion	MCL
2,4,5-Trichlorophenol	7.38E+00	GWP	GWP	1.04E+00	Ingestion	Risk-Based
2,4,6-Trichlorophenol	4.36E-03	GWP	GWP	1.04E-03	Ingestion	Risk-Based
2,4,6-Trinitrotoluene	1.34E-02	GWP	GWP	1.86E-03	Ingestion	Risk-Based
2,4-Dichlorophenol	9.78E-02	GWP	GWP	3.13E-02	Ingestion	Risk-Based
2,4Dichlorophenoxyacetic acid	1.84E+00	GWP	GWP	1.04E-01	Ingestion	Risk-Based
2,4-Dimethylphenol	8.19E-01	GWP	GWP	2.09E-01	Ingestion	Risk-Based
2,4Dinitro-6-sec-butylphenol (Dinoseb)	1.63E-01	GWP	GWP	7.00E-03	Ingestion	MCL

INITIAL DEFAULT TARGET LEVELS (IDTL)

CHEMICALS OF CONCERN	SOIL			GROUNDWATER		
	IDTL [mg/kg]	Critical Pathway	Critical Receptor	IDTL [mg/L]	Critical Pathway	Critical Receptor
2,4-Dinitrophenol	3.84E-02	GWP	GWP	2.09E-02	Ingestion	Risk-Based
2,4-Dinitrotoluene	2.90E-04	GWP	GWP	8.22E-05	Ingestion	Risk-Based
2,6-Dinitrotoluene	2.12E-04	GWP	GWP	8.22E-05	Ingestion	Risk-Based
2-Butanone (Methyl Ethyl Ketone)	1.18E+01	GWP	GWP	6.26E+00	Ingestion	Risk-Based
2-Chloronaphthalene	1.28E+02	GWP	GWP	8.34E-01	Ingestion	Risk-Based
2-Chlorophenol	3.65E-01	GWP	GWP	5.21E-02	Ingestion	Risk-Based
2-Chlorotoluene	1.56E+00	Subsurface Soil	Child	2.09E-01	Ingestion	Risk-Based
2-Methylnaphthalene	3.31E+00	GWP	GWP	4.17E-02	Ingestion	Risk-Based
2-Methylphenol	1.80E+00	GWP	GWP	5.21E-01	Ingestion	Risk-Based
2-Nitroaniline	7.25E-02	GWP	GWP	3.13E-02	Ingestion	Risk-Based
3,3-Dichlorobenzidine	1.83E-03	GWP	GWP	1.24E-04	Ingestion	Risk-Based
3-Nitroaniline	3.18E-03	GWP	GWP	1.47E-03	Ingestion	Risk-Based
4- Bromophenylphenylether	5.45E-03	GWP	GWP	3.72E-06	Ingestion	Risk-Based
4-Chloroaniline	1.26E-01	GWP	GWP	4.17E-02	Ingestion	Risk-Based
4-Methyl-2-pentanone	1.76E+01	GWP	GWP	8.97E+00	Ingestion	Risk-Based
4-Methylphenol	1.41E-01	GWP	GWP	5.21E-02	Ingestion	Risk-Based
4-Nitroaniline	2.99E-03	GWP	GWP	1.47E-03	Ingestion	Risk-Based
4-Nitrophenol	2.26E-01	GWP	GWP	8.34E-02	Ingestion	Risk-Based
Acenaphthene	5.23E+01	GWP	GWP	6.26E-01	Ingestion	Risk-Based
Acenaphthylene	7.80E+01	GWP	GWP	6.26E-01	Ingestion	Risk-Based
Acetochlor	1.12E+00	GWP	GWP	2.09E-01	Ingestion	Risk-Based
Acetone	1.74E+01	GWP	GWP	9.39E+00	Ingestion	Risk-Based
Acrolein	9.65E-03	GWP	GWP	5.21E-03	Ingestion	Risk-Based
Acrylonitrile	1.94E-04	GWP	GWP	1.03E-04	Ingestion	Risk-Based
Alachlor	1.05E-02	GWP	GWP	2.00E-03	Ingestion	MCL
Aldicarb	4.14E-02	GWP	GWP	1.04E-02	Ingestion	Risk-Based
Aldrin	2.11E-02	Surficial Soil	Age-Adjusted	3.29E-06	Ingestion	Risk-Based
Ammonia	4.15E+00	Subsurface Soil	Child	NA	NA	NA
Aniline	1.96E-02	GWP	GWP	9.80E-03	Ingestion	Risk-Based
Anthracene	1.04E+03	GWP	GWP	3.13E+00	Ingestion	Risk-Based
Antimony	4.77E+00	GWP	GWP	6.00E-03	Ingestion	MCL

INITIAL DEFAULT TARGET LEVELS (IDTL)

CHEMICALS OF CONCERN	SOIL			GROUNDWATER		
	IDTL [mg/kg]	Critical Pathway	Critical Receptor	IDTL [mg/L]	Critical Pathway	Critical Receptor
Aroclor 1016	2.33E+00	GWP	GWP	7.30E-04	Ingestion	Risk-Based
Aroclor 1221	2.94E-03	GWP	GWP	2.79E-05	Ingestion	Risk-Based
Aroclor 1242	3.18E-03	GWP	GWP	2.79E-05	Ingestion	Risk-Based
Aroclor 1248	1.37E-01	GWP	GWP	2.79E-05	Ingestion	Risk-Based
Aroclor 1254	7.40E-01	Surficial Soil	Child	2.09E-04	Ingestion	Risk-Based
Aroclor 1260	1.47E-01	Surficial Soil	Age-Adjusted	2.79E-05	Ingestion	Risk-Based
Arsenic	3.91E-01	Surficial Soil	Age-Adjusted	1.00E-02	Ingestion	MCL
Atrazine	1.39E-02	GWP	GWP	3.00E-03	Ingestion	MCL
Azobenzene	1.30E-02	GWP	GWP	5.08E-04	Ingestion	Risk-Based
Barium	8.96E+02	GWP	GWP	2.00E+00	Ingestion	MCL
Benzene	1.78E-02	GWP	GWP	5.00E-03	Ingestion	MCL
Benzidine	5.37E-07	GWP	GWP	2.43E-07	Ingestion	Risk-Based
Benzo(a)anthracene	4.22E-01	Surficial Soil	Age-Adjusted	7.65E-05	Ingestion	Risk-Based
Benzo(a)pyrene	4.22E-02	Surficial Soil	Age-Adjusted	2.00E-04	Ingestion	MCL
Benzo(b)fluoranthene	4.22E-01	Surficial Soil	Age-Adjusted	7.65E-05	Ingestion	Risk-Based
Benzo(g,h,i)perylene	1.18E+03	Surficial Soil	Child	3.13E-01	Ingestion	Risk-Based
Benzo(k)fluoranthene	4.22E+00	Surficial Soil	Age-Adjusted	7.65E-04	Ingestion	Risk-Based
Benzoic acid	7.71E+01	GWP	GWP	4.17E+01	Ingestion	Risk-Based
Benzyl Alcohol	6.43E+00	GWP	GWP	3.13E+00	Ingestion	Risk-Based
Beryllium	1.63E+00	GWP	GWP	4.00E-03	Ingestion	MCL
BHC-alpha ^c	2.10E-04	GWP	GWP	8.87E-06	Ingestion	Risk-Based
BHC-beta	7.51E-04	GWP	GWP	3.10E-05	Ingestion	Risk-Based
BHC-gamma(Lindane)	8.96E-04	GWP	GWP	4.30E-05	Ingestion	Risk-Based
Bis(2-chloroethyl)ether	1.08E-04	GWP	GWP	5.08E-05	Ingestion	Risk-Based
Bis(2-chloroisopropyl)ether	3.11E+00	GWP	GWP	4.17E-01	Ingestion	Risk-Based
Bis(2-ethylhexyl)phthalate	1.18E+01	GWP	GWP	6.00E-03	Ingestion	MCL
Bromodichloromethane	2.68E-03	GWP	GWP	9.01E-04	Ingestion	Risk-Based
Bromoform	2.92E-02	GWP	GWP	7.07E-03	Ingestion	Risk-Based
Bromomethane	5.01E-02	GWP	GWP	1.46E-02	Ingestion	Risk-Based
Butyl benzyl phthalate	5.11E+02	GWP	GWP	2.09E+00	Ingestion	Risk-Based
Cadmium	1.35E+00	GWP	GWP	5.00E-03	Ingestion	MCL

INITIAL DEFAULT TARGET LEVELS (IDTL)

CHEMICALS OF CONCERN	SOIL			GROUNDWATER		
	IDTL [mg/kg]	Critical Pathway	Critical Receptor	IDTL [mg/L]	Critical Pathway	Critical Receptor
Carbofuran	9.42E-02	GWP	GWP	4.00E-02	Ingestion	MCL
Carbon disulfide	5.97E+00	GWP	GWP	1.04E+00	Ingestion	Risk-Based
Carbon Tetrachloride	1.14E-02	Subsurface Soil	Child	4.56E-03	Indoor Inhalation	Age-Adjusted
Chlordane	1.53E+00	Surficial Soil	Age-Adjusted	2.00E-03	Ingestion	MCL
Chlorobenzene	6.18E-01	GWP	GWP	1.00E-01	Ingestion	MCL
Chloroethane	5.33E-02	GWP	GWP	1.93E-02	Ingestion	Risk-Based
Chloroform	5.64E-03	GWP	GWP	1.80E-03	Ingestion	Risk-Based
Chloromethane	2.31E-02	GWP	GWP	4.30E-03	Ingestion	Risk-Based
Chlorpyrifos	2.84E+00	GWP	GWP	3.13E-02	Ingestion	Risk-Based
Chromium (III) total Cr	2.13E+03	GWP	GWP	1.00E-01	Ingestion	MCL
Chromium (VI)	7.90E+00	GWP	GWP	3.13E-02	Ingestion	Risk-Based
Chrysene	3.34E+01	GWP	GWP	7.65E-03	Ingestion	Risk-Based
Copper	9.21E+02	GWP	GWP	1.30E+00	Ingestion	MCL
Cyanide (as Sodium Cyanide)	3.68E-01	GWP	GWP	2.00E-01	Ingestion	MCL
Dacthal	1.58E+01	Subsurface Soil	Child	1.04E-01	Ingestion	Risk-Based
Dalapon (2,2-dichloropropionic acid)	4.57E-01	GWP	GWP	2.00E-01	Ingestion	MCL
DDD ^d	2.44E+00	Surficial Soil	Age-Adjusted	2.33E-04	Ingestion	Risk-Based
DDE ^e	1.72E+00	Surficial Soil	Age-Adjusted	1.64E-04	Ingestion	Risk-Based
DDT ^f	4.03E-01	GWP	GWP	1.64E-04	Ingestion	Risk-Based
Demeton	1.29E-03	GWP	GWP	4.17E-04	Ingestion	Risk-Based
Dibenzo(a,h)anthracene	4.22E-02	Surficial Soil	Age-Adjusted	7.65E-06	Ingestion	Risk-Based
Dibenzofuran	6.10E+00	GWP	GWP	4.17E-02	Ingestion	Risk-Based
Dibromochloromethane	2.02E-03	GWP	GWP	6.65E-04	Ingestion	Risk-Based
Dichlorodifluoromethane	2.96E+00	Subsurface Soil	Child	1.95E-01	Indoor Inhalation	Child
Dieldrin	1.33E-03	GWP	GWP	3.49E-06	Ingestion	Risk-Based
Diethylphthalate	2.75E+01	GWP	GWP	8.34E+00	Ingestion	Risk-Based
Dimethylphthalate	2.71E+02	GWP	GWP	1.04E+02	Ingestion	Risk-Based
Di-n-butyl phthalate	3.10E+01	GWP	GWP	1.04E+00	Ingestion	Risk-Based
Di-n-octyl phthalate	1.83E+03	Surficial Soil	Child	4.17E-01	Ingestion	Risk-Based
Diquat	1.09E-01	GWP	GWP	2.00E-02	Ingestion	MCL

INITIAL DEFAULT TARGET LEVELS (IDTL)

CHEMICALS OF CONCERN	SOIL			GROUNDWATER		
	IDTL [mg/kg]	Critical Pathway	Critical Receptor	IDTL [mg/L]	Critical Pathway	Critical Receptor
Disulfoton	6.68E-02	GWP	GWP	4.17E-04	Ingestion	Risk-Based
Diuron	2.16E-01	GWP	GWP	2.09E-02	Ingestion	Risk-Based
Endosulfan	2.49E+00	GWP	GWP	6.26E-02	Ingestion	Risk-Based
Endothall	3.35E-01	GWP	GWP	1.00E-01	Ingestion	MCL
Endrin	3.35E-01	GWP	GWP	2.00E-03	Ingestion	MCL
Eptam	1.39E+00	GWP	GWP	2.61E-01	Ingestion	Risk-Based
Ethylbenzene	1.02E+01	GWP	GWP	7.00E-01	Ingestion	MCL
Ethylene dibromide(EDB)	1.43E-04	GWP	GWP	5.00E-05	Ingestion	MCL
Fluoranthene	3.64E+02	GWP	GWP	4.17E-01	Ingestion	Risk-Based
Fluorene	5.48E+01	GWP	GWP	4.17E-01	Ingestion	Risk-Based
Fluoride (as Sodium Fluoride)	7.36E+00	GWP	GWP	4.00E+00	Ingestion	MCL
Glyphosate	4.48E+01	GWP	GWP	7.00E-01	Ingestion	MCL
Heptachlor	1.06E-03	Subsurface Soil	Age-Adjusted	4.00E-04	Ingestion	MCL
Heptachlor epoxide	2.61E-02	GWP	GWP	2.00E-04	Ingestion	MCL
Hexachlorobenzene	4.27E-02	Subsurface Soil	Age-Adjusted	1.00E-03	Ingestion	MCL
Hexachlorobutadiene	3.78E-02	Subsurface Soil	Age-Adjusted	7.16E-04	Ingestion	Risk-Based
Hexachlorocyclopentadiene	1.16E-02	Subsurface Soil	Child	7.01E-03	Indoor Inhalation	Child
Hexachloroethane	1.38E-01	GWP	GWP	3.99E-03	Ingestion	Risk-Based
Hexazinone	8.84E-01	GWP	GWP	3.44E-01	Ingestion	Risk-Based
Hydrogen Sulfide	2.96E-02	Subsurface Soil	Child	1.75E-02	Indoor Inhalation	Child
Indeno(1,2,3-cd)pyrene	4.22E-01	Surficial Soil	Age-Adjusted	7.65E-05	Ingestion	Risk-Based
Iron (as Iron Oxide)	5.76E+00	GWP	GWP	3.13E+00	Ingestion	Risk-Based
Isophorone	1.40E-01	GWP	GWP	5.88E-02	Ingestion	Risk-Based
Isopropylbenzene (Cumene)	3.46E+00	GWP	GWP	1.04E+00	Ingestion	Risk-Based
Lead	4.96E+01	GWP	GWP	1.50E-02	Ingestion	MCL
Manganese	2.23E+02	GWP	GWP	2.50E-01	Ingestion	Risk-Based
Mercury	5.09E-03	GWP	GWP	2.00E-03	Ingestion	MCL
Methoxychlor	5.52E+01	GWP	GWP	4.00E-02	Ingestion	MCL
Methylene Chloride	1.69E-02	GWP	GWP	7.45E-03	Ingestion	Risk-Based
Metolachlor	8.43E+00	GWP	GWP	1.56E+00	Ingestion	Risk-Based
Metribuzin	7.21E-01	GWP	GWP	2.61E-01	Ingestion	Risk-Based

INITIAL DEFAULT TARGET LEVELS (IDTL)

CHEMICALS OF CONCERN	SOIL			GROUNDWATER		
	IDTL [mg/kg]	Critical Pathway	Critical Receptor	IDTL [mg/L]	Critical Pathway	Critical Receptor
MTBE ^g	3.64E-02	GWP	GWP	1.69E-02	Ingestion	Risk-Based
Naphthalene	1.14E+00	Subsurface Soil	Child	2.09E-01	Ingestion	Risk-Based
Nickel	5.91E+01	GWP	GWP	2.09E-01	Ingestion	Risk-Based
Nitrate (as Sodium Nitrate)	1.84E+01	GWP	GWP	1.00E+01	Ingestion	MCL
Nitrite (as Sodium Nitrite)	1.84E+00	GWP	GWP	1.00E+00	Ingestion	MCL
Nitrobenzene	2.18E-02	GWP	GWP	5.21E-03	Ingestion	Risk-Based
N-Nitrosodimethylamine	2.09E-06	GWP	GWP	1.10E-06	Ingestion	Risk-Based
N-Nitrosodi-n-propylamine	1.81E-05	GWP	GWP	7.98E-06	Ingestion	Risk-Based
N-Nitrosodiphenylamine	8.80E-02	GWP	GWP	1.14E-02	Ingestion	Risk-Based
Oxamyl (Vydate)	3.86E-01	GWP	GWP	2.00E-01	Ingestion	MCL
Pentachlorophenol	9.07E-03	GWP	GWP	1.00E-03	Ingestion	MCL
Phenanthrene	7.90E+01	GWP	GWP	3.13E-01	Ingestion	Risk-Based
Phenol	7.36E+00	GWP	GWP	3.13E+00	Ingestion	Risk-Based
Picloram	2.95E+00	GWP	GWP	5.00E-01	Ingestion	MCL
Prometon	7.04E-01	GWP	GWP	1.56E-01	Ingestion	Risk-Based
Pyrene	3.59E+02	GWP	GWP	3.13E-01	Ingestion	Risk-Based
sec-Butylbenzene	1.17E+00	Subsurface Soil	Child	1.04E-01	Ingestion	Risk-Based
Selenium	2.03E+00	GWP	GWP	5.00E-02	Ingestion	MCL
Silver	1.89E-01	GWP	GWP	5.21E-02	Ingestion	Risk-Based
Simazine	1.08E-02	GWP	GWP	4.00E-03	Ingestion	MCL
Styrene	1.83E+00	GWP	GWP	1.00E-01	Ingestion	MCL
Terbutryn	3.21E-01	GWP	GWP	1.04E-02	Ingestion	Risk-Based
tert-Butylbenzene	8.52E-01	Subsurface Soil	Child	1.04E-01	Ingestion	Risk-Based
Tetrachloroethene	2.88E-02	Subsurface Soil	Child	5.00E-03	Ingestion	MCL
Thallium	1.55E+00	GWP	GWP	2.00E-03	Ingestion	MCL
Toluene	4.89E+00	GWP	GWP	1.00E+00	Ingestion	MCL
Total Xylenes	1.67E+00	Subsurface Soil	Child	4.34E+00	Indoor Inhalation	Child
Toxaphene	3.26E-01	Surficial Soil	Age-Adjusted	3.00E-03	Ingestion	MCL
Trichloroethene	2.88E-03	Subsurface Soil	Child	3.32E-03	Indoor Inhalation	Age-Adjusted
Trichlorofluoromethane	1.04E+01	Subsurface Soil	Child	2.05E+00	Indoor Inhalation	Child
Vinyl Chloride	9.63E-03	GWP	GWP	2.00E-03	Ingestion	MCL

INITIAL DEFAULT TARGET LEVELS (IDTL)

CHEMICALS OF CONCERN	SOIL			GROUNDWATER		
	IDTL [mg/kg]	Critical Pathway	Critical Receptor	IDTL [mg/L]	Critical Pathway	Critical Receptor
Zinc	8.86E+02	GWP	GWP	3.13E+00	Ingestion	Risk-Based

^aGround Water Protection Via Soils Leaching to Groundwater

^bMaximum contaminant level

^c Benzene hexachloride

^d Dichloro diphenyl dichloroethylene

^e 1,1-Dichloro-2,2-bis(p-chlorophenyl) ethane

^f Dichloro diphenyl trichloroethane

^g Methyl tert-butyl ether

^h Tetrachloro di benzo-p-dioxin

ⁱ 4,5,-Trichlorophenoxy propionic acid

Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems

D. D. MacDonald,¹ C. G. Ingersoll,² T. A. Berger³

¹ MacDonald Environmental Sciences Ltd., 2376 Yellow Point Road, Nanaimo, British Columbia V9X 1W5, Canada

² Columbia Environmental Research Center, U.S. Geological Survey, 4200 New Haven Road, Columbia, Missouri 65201, USA

³ 159-1410 Richmond Avenue, Houston, Texas 77006, USA

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Abstract. Numerical sediment quality guidelines (SQGs) for freshwater ecosystems have previously been developed using a variety of approaches. Each approach has certain advantages and limitations which influence their application in the sediment quality assessment process. In an effort to focus on the agreement among these various published SQGs, consensus-based SQGs were developed for 28 chemicals of concern in freshwater sediments (*i.e.*, metals, polycyclic aromatic hydrocarbons, polychlorinated biphenyls, and pesticides). For each contaminant of concern, two SQGs were developed from the published SQGs, including a threshold effect concentration (TEC) and a probable effect concentration (PEC). The resultant SQGs for each chemical were evaluated for reliability using matching sediment chemistry and toxicity data from field studies conducted throughout the United States. The results of this evaluation indicated that most of the TECs (*i.e.*, 21 of 28) provide an accurate basis for predicting the absence of sediment toxicity. Similarly, most of the PECs (*i.e.*, 16 of 28) provide an accurate basis for predicting sediment toxicity. Mean PEC quotients were calculated to evaluate the combined effects of multiple contaminants in sediment. Results of the evaluation indicate that the incidence of toxicity is highly correlated to the mean PEC quotient ($R^2 = 0.98$ for 347 samples). It was concluded that the consensus-based SQGs provide a reliable basis for assessing sediment quality conditions in freshwater ecosystems.

Numerical sediment quality guidelines (SQGs; including sediment quality criteria, sediment quality objectives, and sediment quality standards) have been developed by various federal, state, and provincial agencies in North America for both freshwater and marine ecosystems. Such SQGs have been used in numerous applications, including designing monitoring programs, interpreting historical data, evaluating the need for detailed sediment quality assessments, assessing the quality of

prospective dredged materials, conducting remedial investigations and ecological risk assessments, and developing sediment quality remediation objectives (Long and MacDonald 1998). Numerical SQGs have also been used by many scientists and managers to identify contaminants of concern in aquatic ecosystems and to rank areas of concern on a regional or national basis (*e.g.*, US EPA 1997a). It is apparent, therefore, that numerical SQGs, when used in combination with other tools, such as sediment toxicity tests, represent a useful approach for assessing the quality of freshwater and marine sediments (MacDonald *et al.* 1992; US EPA 1992, 1996a, 1997a; Adams *et al.* 1992; Ingersoll *et al.* 1996, 1997).

The SQGs that are currently being used in North America have been developed using a variety of approaches. The approaches that have been selected by individual jurisdictions depend on the receptors that are to be considered (*e.g.*, sediment-dwelling organisms, wildlife, or humans), the degree of protection that is to be afforded, the geographic area to which the values are intended to apply (*e.g.*, site-specific, regional, or national), and their intended uses (*e.g.*, screening tools, remediation objectives, identifying toxic and not-toxic samples, bioaccumulation assessment). Guidelines for assessing sediment quality relative to the potential for adverse effects on sediment-dwelling organisms in freshwater systems have been derived using a combination of theoretical and empirical approaches, primarily including the equilibrium partitioning approach (EqPA; Di Toro *et al.* 1991; NYSDEC 1994; US EPA 1997a), screening level concentration approach (SLCA; Persaud *et al.* 1993), effects range approach (ERA; Long and Morgan 1991; Ingersoll *et al.* 1996), effects level approach (ELA; Smith *et al.* 1996; Ingersoll *et al.* 1996), and apparent effects threshold approach (AETA; Cubbage *et al.* 1997). Application of these methods has resulted in the derivation of numerical SQGs for many chemicals of potential concern in freshwater sediments.

Selection of the most appropriate SQGs for specific applications can be a daunting task for sediment assessors. This task is particularly challenging because limited guidance is currently available on the recommended uses of the various SQGs. In addition, the numerical SQGs for any particular substance can differ by several orders of magnitude, depending on the derivation procedure and intended use. The SQG selection process is further complicated due to uncertainties regarding

the bioavailability of sediment-associated contaminants, the effects of covarying chemicals and chemical mixtures, and the ecological relevance of the guidelines (MacDonald *et al.* 2000). It is not surprising, therefore, that controversies have occurred over the proper use of these sediment quality assessment tools.

This paper represents the third in a series that is intended to address some of the difficulties associated with the assessment of sediment quality conditions using various numerical SQGs. The first paper was focused on resolving the “mixture paradox” that is associated with the application of empirically derived SQGs for individual PAHs. In this case, the paradox was resolved by developing consensus SQGs for Σ PAHs (*i.e.*, total PAHs; Swartz 1999). The second paper was directed at the development and evaluation of consensus-based sediment effect concentrations for total PCBs, which provided a basis for resolving a similar mixture paradox for that group of contaminants using empirically derived SQGs (MacDonald *et al.* 2000). The results of these investigations demonstrated that consensus-based SQGs provide a unifying synthesis of the existing guidelines, reflect causal rather than correlative effects, and account for the effects of contaminant mixtures in sediment (Swartz 1999).

The purpose of this third paper is to further address uncertainties associated with the application of numerical SQGs by providing a unifying synthesis of the published SQGs for freshwater sediments. To this end, the published SQGs for 28 chemical substances were assembled and classified into two categories in accordance with their original narrative intent. These published SQGs were then used to develop two consensus-based SQGs for each contaminant, including a threshold effect concentration (TEC; below which adverse effects are not expected to occur) and a probable effect concentration (PEC; above which adverse effects are expected to occur more often than not). An evaluation of resultant consensus-based SQGs was conducted to provide a basis for determining the ability of these tools to predict the presence, absence, and frequency of sediment toxicity in field-collected sediments from various locations across the United States.

Materials and Methods

Derivation of the Consensus-Based SQGs

A stepwise approach was used to develop the consensus-based SQGs for common contaminants of concern in freshwater sediments. As a first step, the published SQGs that have been derived by various investigators for assessing the quality of freshwater sediments were collated. Next, the SQGs obtained from all sources were evaluated to determine their applicability to this study. To facilitate this evaluation, the supporting documentation for each of the SQGs was reviewed. The collated SQGs were further considered for use in this study if: (1) the methods that were used to derive the SQGs were readily apparent; (2) the SQGs were based on empirical data that related contaminant concentrations to harmful effects on sediment-dwelling organisms or were intended to be predictive of effects on sediment-dwelling organisms (*i.e.*, not simply an indicator of background contamination); and (3) the SQGs had been derived on a *de novo* basis (*i.e.*, not simply adopted from another jurisdiction or source). It was not the intent of this paper to collate bioaccumulation-based SQGs.

The SQGs that were expressed on an organic carbon-normalized basis were converted to dry weight-normalized values at 1% organic carbon (MacDonald *et al.* 1994, 1996; US EPA 1997a). The dry

weight-normalized SQGs were utilized because the results of previous studies have shown that they predicted sediment toxicity as well or better than organic carbon-normalized SQGs in field-collected sediments (Barrick *et al.* 1988; Long *et al.* 1995; Ingersoll *et al.* 1996; US EPA 1996a; MacDonald 1997).

The effects-based SQGs that met the selection criteria were then grouped to facilitate the derivation of consensus-based SQGs (Swartz 1999). Specifically, the previously published SQGs for the protection of sediment-dwelling organisms in freshwater ecosystems were grouped into two categories according to their original narrative intent, including TECs and PECs. The TECs were intended to identify contaminant concentrations below which harmful effects on sediment-dwelling organisms were not expected. TECs include threshold effect levels (TELs; Smith *et al.* 1996; US EPA 1996a), effect range low values (ERLs; Long and Morgan 1991), lowest effect levels (LELs; Persaud *et al.* 1993), minimal effect thresholds (METs; EC and MENVIQ 1992), and sediment quality advisory levels (SQALs; US EPA 1997a). The PECs were intended to identify contaminant concentrations above which harmful effects on sediment-dwelling organisms were expected to occur frequently (MacDonald *et al.* 1996; Swartz 1999). PECs include probable effect levels (PELs; Smith *et al.* 1996; US EPA 1996a), effect range median values (ERMs; Long and Morgan 1991); severe effect levels (SELs; Persaud *et al.* 1993), and toxic effect thresholds (TETs; EC and MENVIQ 1992; Table 1).

Following classification of the published SQGs, consensus-based TECs were calculated by determining the geometric mean of the SQGs that were included in this category (Table 2). Likewise, consensus-based PECs were calculated by determining the geometric mean of the PEC-type values (Table 3). The geometric mean, rather than the arithmetic mean or median, was calculated because it provides an estimate of central tendency that is not unduly affected by extreme values and because the distributions of the SQGs were not known (MacDonald *et al.* 2000). Consensus-based TECs or PECs were calculated only if three or more published SQGs were available for a chemical substance or group of substances.

Evaluation of the SQGs

The consensus-based SQGs were critically evaluated to determine if they would provide effective tools for assessing sediment quality conditions in freshwater ecosystems. Specifically, the reliability of the individual or combined consensus-based TECs and PECs for assessing sediment quality conditions was evaluated by determining their predictive ability. In this study, predictive ability is defined as the ability of the various SQGs to correctly classify field-collected sediments as toxic or not toxic, based on the measured concentrations of chemical contaminants. The predictive ability of the SQGs was evaluated using a three-step process.

In the first step of the SQG evaluation process, matching sediment chemistry and biological effects data were compiled for various freshwater locations in the United States. Because the data sets were generated for a wide variety of purposes, each study was evaluated to assure the quality of the data used for evaluating the predictive ability of the SQGs (Long *et al.* 1998; Ingersoll and MacDonald 1999). As a result of this evaluation, data from the following freshwater locations were identified for use in this paper: Grand Calumet River and Indiana Harbor Canal, IN (Hoke *et al.* 1993; Giesy *et al.* 1993; Burton 1994; Dorkin 1994); Indiana Harbor, IN (US EPA 1993a, 1996a, 1996b); Buffalo River, NY (US EPA 1993c, 1996a); Saginaw River, MI (US EPA 1993b, 1996a); Clark Fork River, MT (USFWS 1993); Milltown Reservoir, MT (USFWS 1993); Lower Columbia River, WA (Johnson and Norton 1988); Lower Fox River and Green Bay, WI (Call *et al.* 1991); Potomac River, DC (Schlekat *et al.* 1994; Wade *et al.* 1994; Velinsky *et al.* 1994); Trinity River, TX (Dickson *et al.* 1989; US EPA 1996a); Upper Mississippi River, MN to MO (US EPA 1996a, 1997b);

Table 1. Descriptions of the published freshwater SQGs that have been developed using various approaches

Type of SQG	Acronym	Approach	Description	Reference
<u>Threshold effect concentration SQGs</u>				
Lowest effect level	LEL	SLCA	Sediments are considered to be clean to marginally polluted. No effects on the majority of sediment-dwelling organisms are expected below this concentration.	Persaud <i>et al.</i> (1993)
Threshold effect level	TEL	WEA	Represents the concentration below which adverse effects are expected to occur only rarely.	Smith <i>et al.</i> (1996)
Effect range—low	ERL	WEA	Represents the chemical concentration below which adverse effects would be rarely observed.	Long and Morgan (1991)
Threshold effect level for <i>Hyaella azteca</i> in 28-day tests	TEL-HA28	WEA	Represents the concentration below which adverse effects on survival or growth of the amphipod <i>Hyaella azteca</i> are expected to occur only rarely (in 28-day tests).	US EPA (1996a); Ingersoll <i>et al.</i> (1996)
Minimal effect threshold	MET	SLCA	Sediments are considered to be clean to marginally polluted. No effects on the majority of sediment-dwelling organisms are expected below this concentration.	EC and MENVIQ (1992)
Chronic equilibrium partitioning threshold	SQAL	EqPA	Represents the concentration in sediments that is predicted to be associated with concentrations in the interstitial water below a chronic water quality criterion. Adverse effects on sediment-dwelling organisms are predicted to occur only rarely below this concentration.	Bolton <i>et al.</i> (1985); Zarba (1992); US EPA (1997a)
<u>Probable effect concentration SQGs</u>				
Severe effect level	SEL	SLCA	Sediments are considered to be heavily polluted. Adverse effects on the majority of sediment-dwelling organisms are expected when this concentration is exceeded.	Persaud <i>et al.</i> (1993)
Probable effect level	PEL	WEA	Represents the concentration above which adverse effects are expected to occur frequently.	Smith <i>et al.</i> (1996)
Effect range—median	ERM	WEA	Represents the chemical concentration above which adverse effects would frequently occur.	Long and Morgan (1991)
Probable effect level for <i>Hyaella azteca</i> in 28-day tests	PEL-HA28	WEA	Represents the concentration above which adverse effects on survival or growth of the amphipod <i>Hyaella azteca</i> are expected to occur frequently (in 28-day tests).	US EPA (1996a); Ingersoll <i>et al.</i> (1996)
Toxic effect threshold	TET	SLCA	Sediments are considered to be heavily polluted. Adverse effects on sediment-dwelling organisms are expected when this concentration is exceeded.	EC and MENVIQ (1992)

and Waukegan Harbor, IL (US EPA 1996a; Kemble *et al.* 1999). These studies provided 17 data sets (347 sediment samples) with which to evaluate the predictive ability of the SQGs. These studies also represented a broad range in both sediment toxicity and contamination; roughly 50% of these samples were found to be toxic based on the results of the various toxicity tests (the raw data from these studies are summarized in Ingersoll and MacDonald 1999).

In the second step of the evaluation, the measured concentration of each substance in each sediment sample was compared to the corresponding SQG for that substance. Sediment samples were predicted to

be not toxic if the measured concentrations of a chemical substance were lower than the corresponding TEC. Similarly, samples were predicted to be toxic if the corresponding PECs were exceeded in field-collected sediments. Samples with contaminant concentrations between the TEC and PEC were neither predicted to be toxic nor nontoxic (*i.e.*, the individual SQGs are not intended to provide guidance within this range of concentrations). The comparisons of measured concentrations to the SQGs were conducted for each of the 28 chemicals of concern for which SQGs were developed.

In the third step of the evaluation, the accuracy of each prediction

Table 2. Sediment quality guidelines for metals in freshwater ecosystems that reflect TECs (*i.e.*, below which harmful effects are unlikely to be observed)

	Threshold Effect Concentrations						
Substance	TEL	LEL	MET	ERL	TEL-HA28	SQAL	Consensus-Based TEC
Metals (in mg/kg DW)							
Arsenic	5.9	6	7	33	11	NG	9.79
Cadmium	0.596	0.6	0.9	5	0.58	NG	0.99
Chromium	37.3	26	55	80	36	NG	43.4
Copper	35.7	16	28	70	28	NG	31.6
Lead	35	31	42	35	37	NG	35.8
Mercury	0.174	0.2	0.2	0.15	NG	NG	0.18
Nickel	18	16	35	30	20	NG	22.7
Zinc	123	120	150	120	98	NG	121
Polycyclic aromatic hydrocarbons (in µg/kg DW)							
Anthracene	NG	220	NG	85	10	NG	57.2
Fluorene	NG	190	NG	35	10	540	77.4
Naphthalene	NG	NG	400	340	15	470	176
Phenanthrene	41.9	560	400	225	19	1,800	204
Benz[a]anthracene	31.7	320	400	230	16	NG	108
Benzo(a)pyrene	31.9	370	500	400	32	NG	150
Chrysene	57.1	340	600	400	27	NG	166
Dibenz[a,h]anthracene	NG	60	NG	60	10	NG	33.0
Fluoranthene	111	750	600	600	31	6,200	423
Pyrene	53	490	700	350	44	NG	195
Total PAHs	NG	4,000	NG	4,000	260	NG	1,610
Polychlorinated biphenyls (in µg/kg DW)							
Total PCBs	34.1	70	200	50	32	NG	59.8
Organochlorine pesticides (in µg/kg DW)							
Chlordane	4.5	7	7	0.5	NG	NG	3.24
Dieldrin	2.85	2	2	0.02	NG	110	1.90
Sum DDD	3.54	8	10	2	NG	NG	4.88
Sum DDE	1.42	5	7	2	NG	NG	3.16
Sum DDT	NG	8	9	1	NG	NG	4.16
Total DDTs	7	7	NG	3	NG	NG	5.28
Endrin	2.67	3	8	0.02	NG	42	2.22
Heptachlor epoxide	0.6	5	5	NG	NG	NG	2.47
Lindane (gamma-BHC)	0.94	3	3	NG	NG	3.7	2.37

TEL = Threshold effect level; dry weight (Smith *et al.* 1996)LEL = Lowest effect level, dry weight (Persaud *et al.* 1993)

MET = Minimal effect threshold; dry weight (EC and MENVIQ 1992)

ERL = Effect range low; dry weight (Long and Morgan 1991)

TEL-HA28 = Threshold effect level for *Hyalella azteca*; 28 day test; dry weight (US EPA 1996a)

SQAL = Sediment quality advisory levels; dry weight at 1% OC (US EPA 1997a)

NG = No guideline

was evaluated by determining if the sediment sample actually was toxic to one or more aquatic organisms, as indicated by the results of various sediment toxicity tests (Ingersoll and MacDonald 1999). The following responses of aquatic organisms to contaminant challenges (*i.e.*, toxicity test endpoints) were used as indicators of toxicity in this assessment (*i.e.*, sediment samples were designated as toxic if one or more of the following endpoints were significantly different from the responses observed in reference or control sediments), including amphipod (*Hyalella azteca*) survival, growth, or reproduction; mayfly (*Hexagenia limbata*) survival or growth; midge (*Chironomus tentans* or *Chironomus riparius*) survival or growth; midge deformities; oligochaete (*Lumbriculus variegatus*) survival; daphnid (*Ceriodaphnia dubia*) survival; and bacterial (*Photobacterium phosphoreum*) luminescence (*i.e.*, Microtox). In contrast, sediment samples were designated as nontoxic if they did not cause a significant response in at least one of these test endpoints. In this study, predictive ability was calculated as the ratio of the number of samples that were correctly

classified as toxic or nontoxic to the total number of samples that were predicted to be toxic or nontoxic using the various SQGs (predictive ability was expressed as a percentage).

The criteria for evaluating the reliability of the consensus-based PECs were adapted from Long *et al.* (1998). These criteria are intended to reflect the narrative intent of each type of SQG (*i.e.*, sediment toxicity should be observed only rarely below the TEC and should be frequently observed above the PEC). Specifically, the individual TECs were considered to provide a reliable basis for assessing the quality of freshwater sediments if more than 75% of the sediment samples were correctly predicted to be not toxic. Similarly, the individual PEC for each substance was considered to be reliable if greater than 75% of the sediment samples were correctly predicted to toxic using the PEC. Therefore, the target levels of both false positives (*i.e.*, samples incorrectly classified as toxic) and false negatives (*i.e.*, samples incorrectly classified as not toxic) was 25% using the TEC and PEC. To assure that the results of the predictive ability evaluation were

Table 3. Sediment quality guidelines for metals in freshwater ecosystems that reflect PECs (*i.e.*, above which harmful effects are likely to be observed)

	Probable Effect Concentrations					Consensus- Based PEC
Substance	PEL	SEL	TET	ERM	PEL-HA28	
Metals (in mg/kg DW)						
Arsenic	17	33	17	85	48	33.0
Cadmium	3.53	10	3	9	3.2	4.98
Chromium	90	110	100	145	120	111
Copper	197	110	86	390	100	149
Lead	91.3	250	170	110	82	128
Mercury	0.486	2	1	1.3	NG	1.06
Nickel	36	75	61	50	33	48.6
Zinc	315	820	540	270	540	459
Polycyclic aromatic hydrocarbons (in µg/kg DW)						
Anthracene	NG	3,700	NG	960	170	845
Fluorene	NG	1,600	NG	640	150	536
Naphthalene	NG	NG	600	2,100	140	561
Phenanthrene	515	9,500	800	1,380	410	1,170
Benz[a]anthracene	385	14,800	500	1,600	280	1,050
Benzo(a)pyrene	782	14,400	700	2,500	320	1,450
Chrysene	862	4,600	800	2,800	410	1,290
Fluoranthene	2,355	10,200	2,000	3,600	320	2,230
Pyrene	875	8,500	1,000	2,200	490	1,520
Total PAHs	NG	100,000	NG	35,000	3,400	22,800
Polychlorinated biphenyls (in µg/kg DW)						
Total PCBs	277	5,300	1,000	400	240	676
Organochlorine pesticides (in µg/kg DW)						
Chlordane	8.9	60	30	6	NG	17.6
Dieldrin	6.67	910	300	8	NG	61.8
Sum DDD	8.51	60	60	20	NG	28.0
Sum DDE	6.75	190	50	15	NG	31.3
Sum DDT	NG	710	50	7	NG	62.9
Total DDTs	4,450	120	NG	350	NG	572
Endrin	62.4	1,300	500	45	NG	207
Heptachlor Epoxide	2.74	50	30	NG	NG	16.0
Lindane (gamma-BHC)	1.38	10	9	NG	NG	4.99

PEL = Probable effect level; dry weight (Smith *et al.* 1996)

SEL = Severe effect level, dry weight (Persaud *et al.* 1993)

TET = Toxic effect threshold; dry weight (EC and MENVIQ 1992)

ERM = Effect range median; dry weight (Long and Morgan 1991)

PEL-HA28 = Probable effect level for *Hyaella azteca*; 28-day test; dry weight (US EPA 1996a)

NG = No guideline

not unduly influenced by the number of sediment samples available to conduct the evaluation of predictive ability, the various SQGs were considered to be reliable only if a minimum of 20 samples were included in the predictive ability evaluation (CCME 1995).

The initial evaluation of predictive ability was focused on determining the ability of each SQG when applied alone to classify samples correctly as toxic or nontoxic. Because field-collected sediments typically contain complex mixtures of contaminants, the predictability of these sediment quality assessment tools is likely to increase when the SQGs are used together to classify these sediments. For this reason, a second evaluation of the predictive ability of the SQGs was conducted to determine the incidence of effects above and below various mean PEC quotients (*i.e.*, 0.1, 0.5, 1.0, and 1.5). In this evaluation, mean PEC quotients were calculated using the methods of Long *et al.* (1998; *i.e.*, for each sediment sample, the average of the ratios of the concentration of each contaminant to its corresponding PEC was calculated for each sample), with only the PECs that were found to be reliable used in these calculations. The PEC for total PAHs (*i.e.*,

instead of the PECs for the individual PAHs) was used in the calculation to avoid double counting of the PAH concentration data.

Results and Discussion

Derivation of Consensus-Based SQGs

A variety of approaches have been developed to support the derivation of numerical SQGs for the protection of sediment-dwelling organisms in the United States and Canada. MacDonald (1994), Ingersoll and MacDonald (1999), and MacDonald *et al.* (2000) provided reviews of the various approaches to SQG development, including descriptions of the derivation methods, the advantages and limitations of the resultant SQGs, and their recommended uses. This information,

along with the supporting documentation that was obtained with the published SQGs, was used to evaluate the relevance of the various SQGs in this investigation.

Subsequently, the narrative descriptions of the various SQGs were used to classify the SQGs into appropriate categories (*i.e.*, TECs or PECs; Table 1). The results of this classification process indicated that six sets of SQGs were appropriate for deriving consensus-based TECs for the contaminants of concern in freshwater sediments, including: (1) TELs (Smith *et al.* 1996); (2) LELs (Persaud *et al.* 1993); (3) METs (EC and MENVIQ 1992); (4) ERLs (Long and Morgan 1991); (5) TELs for *H. azteca* in 28-day toxicity tests (US EPA 1996a; Ingersoll *et al.* 1996); and (6) SQALs (US EPA 1997a).

Several other SQGs were also considered for deriving consensus TECs, but they were not included for the following reasons. First, none of the SQGs that have been developed using data on the effects on sediment-associated contaminants in marine sediments only were used to derive TECs. However, the ERLs that were derived using both freshwater and marine data were included (*i.e.*, Long and Morgan 1991). Second, the ERLs that were developed by the US EPA (1996a) were not utilized because they were developed from the same data that were used to derive the TELs (*i.e.*, from several areas of concern in the Great Lakes). In addition, simultaneously extracted metals–acid volatile sulfide (SEM-AVS)–based SQGs were not used because they could not be applied without simultaneous measurements of SEM and AVS concentrations (Di Toro *et al.* 1990). None of the SQGs that were derived using the sediment background approach were used because they were not effects-based. Finally, no bioaccumulation-based SQGs were used to calculate the consensus-based TECs. The published SQGs that corresponded to TECs for metals, PAHs, PCBs, and organochlorine pesticides are presented in Table 2.

Based on the results of the initial evaluation, five sets of SQGs were determined to be appropriate for calculating consensus-based PECs for the contaminants of concern in freshwater sediments, including: (1) probable effect levels (PELs; Smith *et al.* 1996); (2) severe effect levels (SELs; Persaud *et al.* 1993); (3) toxic effect thresholds (TETs; EC and MENVIQ 1992); (4) effect range median values (ERMs; Long and Morgan 1991); and (5) PELs for *H. azteca* in 28-day toxicity tests (US EPA 1996a; Ingersoll *et al.* 1996).

While several other SQGs were considered for deriving the consensus-based PECs, they were not included for the following reasons. To maximize the applicability of the resultant guidelines to freshwater systems, none of the SQGs that were developed for assessing the quality of marine sediments were used to derive the freshwater PECs. As was the case for the TECs, the ERLs that were derived using both freshwater and marine data (*i.e.*, Long and Morgan 1991) were included, however. The ERLs that were derived using data from various areas of concern in the Great Lakes (*i.e.*, US EPA 1996a) were not included to avoid duplicate representation of these data in the consensus-based PECs. In addition, none of the SEM-AVS–based SQGs were not used in this evaluation. Furthermore, none of the AET or related values (*e.g.*, NECs from Ingersoll *et al.* 1996; PAETs from Cabbage *et al.* 1997) were used because they were not considered to represent toxicity thresholds (rather, they represent contaminant concentrations above which harmful biological effects always occur). The

published SQGs that corresponded to PECs for metals, PAHs, PCBs, and organochlorine pesticides are presented in Table 3.

For each substance, consensus-based TECs or PECs were derived if three or more acceptable SQGs were available. The consensus-based TECs or PECs were determined by calculating the geometric mean of the published SQGs and rounding to three significant digits. Application of these procedures facilitated the derivation of numerical SQGs for a total of 28 chemical substances, including 8 trace metals, 10 individual PAHs and PAH classes, total PCBs, and 9 organochlorine pesticides and degradation products. The consensus-based SQGs that were derived for the contaminants of concern in freshwater ecosystems are presented in Tables 2 and 3.

Predictive Ability of the Consensus-Based SQGs

Matching sediment chemistry and toxicity data from various locations in the United States were used to evaluate the predictive ability of the consensus-based SQGs in freshwater sediments. Within this independent data set, the overall incidence of toxicity was about 50% (*i.e.*, 172 of the 347 samples evaluated in these studies were identified as being toxic to one or more sediment-dwelling organisms). Therefore, 50% of the samples with contaminant concentrations below the TEC, between the TEC and the PEC, and above PECs would be predicted to be toxic if sediment toxicity was unrelated to sediment chemistry (*i.e.*, based on random chance alone).

The consensus-based TECs are intended to identify the concentrations of sediment-associated contaminants below which adverse effects on sediment-dwelling organisms are not expected to occur. Sufficient data were available to evaluate the predictive ability of all 28 consensus-based TECs. Based on the results of this assessment, the incidence of sediment toxicity was generally low at contaminant concentrations below the TECs (Table 4). Except for mercury, the predictive ability of the TECs for the trace metals ranged from 72% for chromium to 82% for copper, lead, and zinc. The predictive ability of the TECs for PAHs was similar to that for the trace metals, ranging from 71% to 83%. Among the organochlorine pesticides, the predictive ability of the TECs was highest for chlordane (85%) and lowest for endrin (71%). At 89%, the predictive ability of the TEC for total PCBs was the highest observed among the 28 substances for which SQGs were derived. Overall, the TECs for 21 substances, including four trace metals, eight individual PAHs, total PAHs, total PCBs, and seven organochlorine pesticides, were found to predict accurately the absence of toxicity in freshwater sediments (*i.e.*, predictive ability $\geq 75\%$; ≥ 20 samples below the TEC; Table 4). Therefore, the consensus-based TECs generally provide an accurate basis for predicting the absence of toxicity to sediment-dwelling organisms in freshwater sediments.

In contrast to the TECs, the consensus-based PECs are intended to define the concentrations of sediment-associated contaminants above which adverse effects on sediment-dwelling organisms are likely to be observed. Sufficient data were available to evaluate the PECs for 17 chemical substances, including 7 trace metals, 6 individual PAHs, total PAHs, total PCBs, and 2 organochlorine pesticides (*i.e.*, ≥ 20 samples predicted to be toxic). The results of the evaluation of predictive ability demonstrate that the PECs for 16 of the 17 substances meet the criteria for predictive ability that

Table 4. Predictive ability of the consensus-based TECs in freshwater sediments

Substance	Number of Samples Evaluated	Number of Samples Predicted to Be Not Toxic	Number of Samples Observed to Be Not Toxic	Percentage of Samples Correctly Predicted to Be Not Toxic
Metals				
Arsenic	150	58	43	74.1
Cadmium	347	102	82	80.4
Chromium	347	132	95	72.0
Copper	347	158	130	82.3
Lead	347	152	124	81.6
Mercury	79	35	12	34.3
Nickel	347	184	133	72.3
Zinc	347	163	133	81.6
Polycyclic aromatic hydrocarbons				
Anthracene	129	75	62	82.7
Fluorene	129	93	66	71.0
Naphthalene	139	85	64	75.3
Phenanthrene	139	79	65	82.3
Benz(a)anthracene	139	76	63	82.9
Benzo(a)pyrene	139	81	66	81.5
Chrysene	139	80	64	80.0
Dibenz(a,h)anthracene	98	77	56	72.7
Fluoranthene	139	96	72	75.0
Pyrene	139	78	62	79.5
Total PAHs	167	81	66	81.5
Polychlorinated biphenyls				
Total PCBs	120	27	24	88.9
Organochlorine pesticides				
Chlordane	193	101	86	85.1
Dieldrin	180	109	91	83.5
Sum DDD	168	101	81	80.2
Sum DDE	180	105	86	81.9
Sum DDT	96	100	77	77.0
Total DDT	110	92	76	82.6
Endrin	170	126	89	70.6
Heptachlor epoxide	138	90	74	82.2
Lindane	180	121	87	71.9

were established in this study (Table 5). Among the seven individual trace metals, the predictive ability of the PECs ranged from 77% for arsenic to 94% for cadmium. The PECs for six individual PAHs and total PAHs were also demonstrated to be reliable, with predictive abilities ranging from 92% to 100%. The predictive ability of the PEC for total PCBs was 82%. While the PEC for Sum DDE was also found to be an accurate predictor of sediment toxicity (*i.e.*, predictive ability of 97%), the predictive ability of the PEC for chlordane was somewhat lower (*i.e.*, 73%). Therefore, the consensus-based PECs for arsenic, cadmium, chromium, copper, lead, nickel, zinc, naphthalene, phenanthrene, benz[a]anthracene, benzo(a)pyrene, chrysene, pyrene, total PAHs, total PCBs, and sum DDE provide an accurate basis for predicting toxicity in freshwater sediments from numerous locations in North America (*i.e.*, predictive ability of $\geq 75\%$; Table 5). Insufficient data were available (*i.e.*, fewer than 20 samples predicted to be toxic) to evaluate the PECs for mercury, anthracene, fluorene, fluoranthene, dieldrin, sum DDD, sum DDT, total DDT, endrin, heptachlor epoxide, and lindane (Table 5).

The two types of SQGs define three ranges of concentrations for each chemical substance. It is possible to assess the degree of concordance that exists between chemical concentrations and the incidence of sediment toxicity (Table 6; MacDonald *et al.* 1996)

by determining the ratio of toxic samples to the total number of samples within each of these three ranges of concentrations for each substance. The results of this evaluation demonstrate that, for most chemical substances (*i.e.*, 20 of 28), there is a consistent and marked increase in the incidence of toxicity to sediment-dwelling organisms with increasing chemical concentrations. For certain substances, such as naphthalene, mercury, chlordane, dieldrin, and sum DDD, a lower PEC may have produced greater concordance between sediment chemistry and the incidence of effects. Insufficient data were available to evaluate the degree of concordance for several substances, such as endrin, heptachlor epoxide, and lindane. The positive correlation between contaminant concentrations and sediment toxicity that was observed increases the degree of confidence that can be placed in the SQGs for most of the substances.

While the SQGs for the individual chemical substances provide reliable tools for assessing sediment quality conditions, predictive ability should be enhanced when used together in assessments of sediment quality. In addition, it would be helpful to consider the magnitude of the exceedances of the SQGs in such assessments. Long *et al.* (1998) developed a procedure for evaluating the biological significance of contaminant mixtures through the application of mean PEC quotients. A three-

Table 5. Predictive ability of the consensus-based PECs in freshwater sediments

Substance	Number of Samples Evaluated	Number of Samples Predicted to Be Toxic	Number of Samples Observed to Be Toxic	Percentage of Samples Correctly Predicted to Be Toxic
Metals				
Arsenic	150	26	20	76.9
Cadmium	347	126	118	93.7
Chromium	347	109	100	91.7
Copper	347	110	101	91.8
Lead	347	125	112	89.6
Mercury	79	4	4	100
Nickel	347	96	87	90.6
Zinc	347	120	108	90.0
Polycyclic aromatic hydrocarbons				
Anthracene	129	13	13	100
Fluorene	129	13	13	100
Naphthalene	139	26	24	92.3
Phenanthrene	139	25	25	100
Benz(a)anthracene	139	20	20	100
Benzo(a)pyrene	139	24	24	100
Chrysene	139	24	23	95.8
Fluoranthene	139	15	15	100
Pyrene	139	28	27	96.4
Total PAHs	167	20	20	100
Polychlorinated biphenyls				
Total PCBs	120	51	42	82.3
Organochlorine pesticides				
Chlordane	193	37	27	73.0
Dieldrin	180	10	10	100
Sum DDD	168	6	5	83.3
Sum DDE	180	30	29	96.7
Sum DDT	96	12	11	91.7
Total DDT	110	10	10	100
Endrin	170	0	0	NA
Heptachlor epoxide	138	8	3	37.5
Lindane	180	17	14	82.4

NA = Not applicable

step process is used in the present study to calculate mean PEC quotients. In the first step, the concentration of each substance in each sediment sample is divided by its respective consensus-based PEC. PEC quotients are calculated only for those substances for which reliable PECs were available. Subsequently, the sum of the PEC quotients was calculated for each sediment sample by adding the PEC quotients that were determined for each substance; however, only the PECs that were demonstrated to be reliable were used in the calculation. The summed PEC quotients were then normalized to the number of PEC quotients that are calculated for each sediment sample (*i.e.*, to calculate the mean PEC quotient for each sample; Canfield *et al.* 1998; Long *et al.* 1998; Kemble *et al.* 1999). This normalization step is conducted to provide comparable indices of contamination among samples for which different numbers of chemical substances were analyzed.

The predictive ability of the PEC quotients, as calculated using the consensus-based SQGs, was also evaluated using data that were assembled to support the predictive ability assessment for the individual PECs. In this evaluation, sediment samples were predicted to be not toxic if mean PEC quotients were <0.1 or <0.5 . In contrast, sediment samples were predicted to be toxic when mean PEC quotients exceeded

0.5, 1.0, or 1.5. The results of this evaluation indicated that the consensus-based SQGs, when used, together provide an accurate basis for predicting the absence of sediment toxicity (Table 7; Figure 1). Sixty-one sediment samples had mean PEC quotients of <0.1 ; six of these samples were toxic to sediment-dwelling organisms (predictive ability = 90%). Of the 174 samples with mean PEC quotients of <0.5 , only 30 were found to be toxic to sediment-dwelling organisms (predictive ability = 83%; Table 7).

The consensus-based SQGs also provided an accurate basis for predicting sediment toxicity in sediments that contained mixtures of contaminants. Of the 173 sediment samples with mean PEC quotients of >0.5 (calculated using the PECs for seven trace metals, the PEC for total PAHs [rather than the PECs for individual PAHs], the PEC for PCBs, and the PEC for sum DDE), 147 (85%) were toxic to sediment-dwelling organisms (Table 7; Figure 1). Similarly, 92% of the sediment samples (132 of 143) with mean PEC quotients of >1.0 were toxic to one or more species of aquatic organisms. Likewise, 94% of the sediment samples (118 of 125) with mean PEC quotients of greater than 1.5 were found to be toxic, based on the results of various freshwater toxicity tests. Therefore, it is apparent that a mean PEC quotient of 0.5 represents a useful

Table 6. Incidence of toxicity within ranges of contaminant concentrations defined by the SQGs

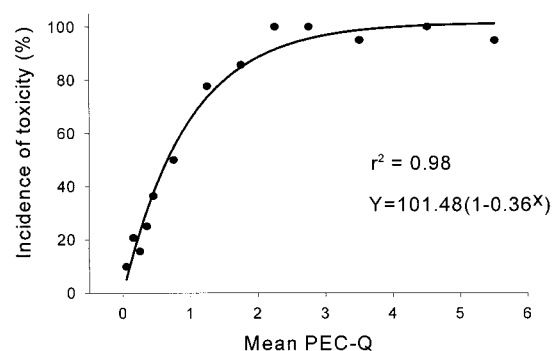
	Number of Samples Evaluated	Incidence of Toxicity (% , number of samples in parentheses)		
Substance		≤TEC	TEC-PEC	> PEC
Metals				
Arsenic	150	25.9% (15 of 58)	57.6% (38 of 66)	76.9% (20 of 26)
Cadmium	347	19.6% (20 of 102)	44.6% (29 of 65)	93.7% (118 of 126)
Chromium	347	28% (37 of 132)	64.4% (38 of 59)	91.7% (100 of 109)
Copper	347	17.7% (28 of 158)	64.0% (48 of 75)	91.8% (101 of 110)
Lead	347	18.4% (28 of 152)	53.6% (37 of 69)	89.6% (112 of 125)
Mercury	79	65.7% (23 of 35)	70.0% (28 of 40)	100% (4 of 4)
Nickel	347	27.7% (51 of 184)	62.7% (32 of 51)	90.6% (87 of 96)
Zinc	347	18.4% (30 of 163)	60.9% (39 of 64)	90.0% (108 of 120)
Polycyclic aromatic hydrocarbons				
Anthracene	129	17.3% (13 of 75)	92.9% (26 of 28)	100% (13 of 13)
Fluorene	129	29% (27 of 93)	85.7% (12 of 14)	100% (13 of 13)
Naphthalene	139	24.7% (21 of 85)	94.1% (16 of 17)	92.3% (24 of 26)
Phenanthrene	139	17.7% (14 of 79)	88.2% (30 of 34)	100% (25 of 25)
Benz(a)anthracene	139	17.1% (13 of 76)	70% (14 of 20)	100% (20 of 20)
Benzo(a)pyrene	139	18.5% (15 of 81)	75.7% (28 of 37)	100% (24 of 24)
Chrysene	139	20% (16 of 80)	68.1% (32 of 47)	95.8% (23 of 24)
Fluoranthene	139	25% (24 of 96)	82.5% (33 of 40)	100% (15 of 15)
Pyrene	139	20.5% (16 of 78)	63.0% (29 of 46)	96.4% (27 of 28)
Total PAHs	167	18.5% (15 of 81)	65.1% (43 of 66)	100% (20 of 20)
Polychlorinated biphenyls				
Total PCBs	120	11.1% (3 of 27)	31.0% (9 of 29)	82.3% (42 of 51)
Organochlorine pesticides				
Chlordane	193	14.9% (15 of 101)	75.0% (15 of 20)	73.0% (27 of 37)
Dieldrin	180	16.5% (18 of 109)	95.2% (20 of 21)	100% (10 of 10)
Sum DDD	168	19.8% (20 of 101)	33.3% (1 of 3)	83.3% (5 of 6)
Sum DDE	180	18.1% (19 of 105)	33.3% (1 of 3)	96.7% (29 of 30)
Sum DDT	96	23% (23 of 100)	0.0% (0 of 1)	91.7% (11 of 12)
Total DDT	110	17.4% (16 of 92)	100% (23 of 23)	100% (10 of 10)
Endrin	170	29.4% (37 of 126)	40.0% (4 of 10)	NA% (0 of 0)
Heptachlor epoxide	138	17.8% (16 of 90)	85.0% (17 of 20)	37.5% (3 of 8)
Lindane	180	28.1% (34 of 121)	65.9% (29 of 44)	82.4% (14 of 17)

Table 7. Predictive ability of mean PEC quotients in freshwater sediments

Mean PEC Quotient	Mean PEC Quotients Calculated with Total PAHs Predictive Ability (%)	Mean PEC Quotients Calculated with Individual PAH Predictive Abilities (%)
<0.1	90.2% (61)	90.2% (61)
<0.5	82.8% (174)	82.9% (175)
>0.5	85% (173)	85.4% (172)
>1.0	93.3% (143)	93.4% (143)
>1.5	94.4% (125)	95% (121)

threshold that can be used to accurately classify sediment samples as both toxic and not toxic. The results of this evaluation were not substantially different when the PECs for the individuals PAHs (*i.e.*, instead of the PEC for total PAHs) were used to calculate the mean PEC quotients (Table 7). Kemble *et al.* (1999) reported similar results when the mean PEC quotients were evaluated using the results of only 28-day toxicity tests with *H. azteca* ($n = 149$, 32% of the samples were toxic).

To examine further the relationship between the degree of chemical contamination and probability of observing toxicity

**Fig. 1.** Relationship between mean PEC quotient and incidence of toxicity in freshwater sediments

in freshwater sediments, the incidence of toxicity within various ranges of mean PEC quotients was calculated (*e.g.*, < 0.1, 0.1–0.2, 0.2–0.3). Next, these data were plotted against the midpoint of each range of mean PEC quotients (Figure 1). Subsequent curve-fitting indicated that the mean PEC-quotient is highly correlated with incidence of toxicity ($r^2 = 0.98$), with the relationship being an exponential function. The resultant

equation can be used to estimate the probability of observing sediment toxicity at any mean PEC quotient.

Although it is important to be able to predict accurately the presence and absence of toxicity in field-collected sediments, it is also helpful to be able to identify the factors that are causing or substantially contributing to sediment toxicity. Such information enables environmental managers to focus limited resources on the highest-priority sediment quality issues and concerns. In this context, it has been suggested that the results of spiked sediment toxicity tests provide a basis for identifying the concentrations of sediment-associated contaminants that cause sediment toxicity (Swartz *et al.* 1988; Ingersoll *et al.* 1997). Unfortunately, there is limited relevant data available that assesses effects of spiked sediment in freshwater systems. For example, the available data from spiked sediment toxicity tests is limited to just a few of the chemical substances for which reliable PECs are available, primarily copper and fluoranthene. Additionally, differences in spiking procedures, equilibration time, and lighting conditions during exposures confound the interpretation of the results of sediment spiking studies, especially for PAHs (ASTM 1999). Moreover, many sediment spiking studies were conducted to evaluate bioaccumulation using relatively insensitive test organisms (*e.g.*, *Diporeia* and *Lumbriculus*) or in sediments containing mixtures of chemical substances (Landrum *et al.* 1989, 1991).

In spite of the limitations associated with the available dose-response data, the consensus-based PECs for copper and fluoranthene were compared to the results of spiked sediment toxicity tests. Suedel (1995) conducted a series of sediment spiking studies with copper and reported 48-h to 14-day LC₅₀s for four freshwater species, including the waterfleas *Ceriodaphnia dubia* (32–129 mg/kg DW) and *Daphnia magna* (37–170 mg/kg DW), the amphipod *H. azteca* (247–424 mg/kg DW), and the midge *C. tentans* (1,026–4,522 mg/kg DW). An earlier study reported 10-day LC₅₀s of copper for *H. azteca* (1,078 mg/kg) and *C. tentans* (857 mg/kg), with somewhat higher effect concentrations observed in different sediment types (Cairns *et al.* 1984). The PEC for copper (149 mg/kg DW) is higher than or comparable to (*i.e.*, within a factor of three; MacDonald *et al.* 1996; Smith *et al.* 1996) the median lethal concentrations for several of these species. For fluoranthene, Suedel and Rodgers (1993) reported 10-day EC₅₀s of 4.2–15.0 mg/kg, 2.3–7.4 mg/kg, and 3.0–8.7 mg/kg for *D. magna*, *H. azteca*, and *C. tentans*, respectively. The lower of the values reported for each species are comparable to the PEC for fluoranthene that was derived in this study (*i.e.*, 2.23 mg/kg). Much higher toxicity thresholds have been reported in other studies (*e.g.*, Kane Driscoll *et al.* 1997; Kane Driscoll and Landrum 1997), but it is likely that these results were influenced by the lighting conditions under which the tests were conducted. Although this evaluation was made with limited data, the results suggest that the consensus-based SQGs are comparable to the acute toxicity thresholds that have been obtained from spiking studies.

A second approach—to identify concentrations of sediment-associated contaminants that cause or contribute to toxicity—was to compare our consensus-based PECs to equilibrium partitioning values (Swartz 1999; MacDonald *et al.* 1999). The equilibrium partitioning (EqP) approach provides a theoretical basis for deriving sediment quality guidelines for the protection of freshwater organisms (Di Toro *et al.* 1991; Zarba 1992).

Using this approach, the US EPA (1997a) developed SQGs that are intended to represent chronic toxicity thresholds for various sediment-associated contaminants, primarily nonionic organic substances. The concentrations of these contaminants are considered to be sufficient to cause or substantially contribute to sediment toxicity when they exceed the EqP-based SQGs (Berry *et al.* 1996). To evaluate the extent to which the consensus-based SQGs are causally based, the PECs were compared to the chronic toxicity thresholds that have been developed previously using the EqP approach (see Table 2). The results of this evaluation indicate that the consensus-based PECs are generally comparable to the EqP-based SQGs (*i.e.*, within a factor of three; MacDonald *et al.* 1996; Smith *et al.* 1996). Therefore, the consensus-based PECs also define concentrations of sediment-associated contaminants that are sufficient to cause or substantially contribute to sediment toxicity.

Summary

Consensus-based SQGs were derived for 28 common chemicals of concern in freshwater sediments. For each chemical substance, two consensus-based SQGs were derived from the published SQGs. These SQGs reflect the toxicity of sediment-associated contaminants when they occur in mixtures with other contaminants. Therefore, these consensus-based SQGs are likely to be directly relevant for assessing freshwater sediments that are influenced by multiple sources of contaminants. The results of the evaluations of predictive ability demonstrate that the TECs and PECs for most of these chemicals, as well as the PEC quotients, provide a reliable basis for classifying sediments as not toxic and toxic. In addition, positive correlations between sediment chemistry and sediment toxicity indicate that many of these sediment-associated contaminants are associated with the effects that were observed in field-collected sediments. Furthermore, the level of agreement between the available dose-response data, the EqP-based SQGs, and the consensus-based SQGs indicates that sediment-associated contaminants are likely to cause or substantially contribute to, as opposed to simply be associated with, sediment toxicity at concentrations above the PECs.

Overall, the results of the various evaluations demonstrate that the consensus-based SQGs provide a unifying synthesis of the existing SQGs, reflect causal rather than correlative effects, and account for the effects of contaminant mixtures (Swartz 1999). As such, the SQGs can be used to identify hot spots with respect to sediment contamination, determine the potential for and spatial extent of injury to sediment-dwelling organisms, evaluate the need for sediment remediation, and support the development of monitoring programs to further assess the extent of contamination and the effects of contaminated sediments on sediment-dwelling organisms. These applications are strengthened when the SQGs are used in combination with other sediment quality assessment tools (*i.e.*, sediment toxicity tests, bioaccumulation assessments, benthic invertebrate community assessments; Ingersoll *et al.* 1997). In these applications, the TECs should be used to identify sediments that are unlikely to be adversely affected by sediment-associated contaminants. In contrast, the PECs should be used to identify sediments that are likely to be toxic to sediment-dwelling

organisms. The PEC quotients should be used to assess sediment that contain complex mixtures of chemical contaminants.

The consensus-based SQGs described in this paper do not consider the potential for bioaccumulation in aquatic organisms nor the associated hazards to the species that consume aquatic organisms (*i.e.*, wildlife and humans). Therefore, it is important to use the consensus-based SQGs in conjunction with other tools, such as bioaccumulation-based SQGs, bioaccumulation tests, and tissue residue guidelines, to evaluate more fully the potential effects of sediment-associated contaminants in the environment. Future investigations should focus of evaluating the predictive ability of these sediment assessment tools on a species- and endpoint-specific basis for various geographic areas.

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References

- Adams WJ, Kimerle RA, Barnett JW Jr (1992) Sediment quality and aquatic life assessment. *Environ Sci Technol* 26:1863–1876
- ASTM (American Society for Testing and Materials) (1999) Standard guide for determination of bioaccumulation of sediment-associated contaminants in benthic invertebrates. E1688-97a, ASTM 1999 Annual Book of Standards, vol. 11.05, Conshohocken, PA
- Barrick R, Becker S, Pastorok R, Brown L, Beller H (1988) Sediment quality values refinement: 1988 update and evaluation of Puget Sound AET. Prepared by PTI Environmental Services for Environmental Protection Agency, Bellevue, WA
- Berry WJ, Hansen DJ, Mahoney JD, Robson DL, Di Toro DM, Shipley DP, Rogers B, Corbin JM, Boothman WS (1996) Predicting the toxicity of metal-spiked laboratory sediments using acid-volatile sulfide and interstitial water normalizations. *Environ Toxicol Chem* 15:2067–2079
- Bolton SH, Breteler RJ, Vigon BW, Scanlon JA, Clark SL (1985) National perspective on sediment quality. Prepared for the US Environmental Protection Agency, Washington, DC, 194 pp
- Burton A (1994) Sediment sampling and analysis plan—West Branch Grand Calumet River: 1993 sediment toxicity test data summaries. Prepared for Environmental Science Division, US Environmental Protection Agency, Region V, Chicago, IL
- Cairns MA, Nebeker AV, Gakstater JH, Griffis WL (1984) Toxicity of copper-spiked sediments to freshwater invertebrates. *Environ Toxicol Chem* 3:435–445
- Call DJ, Balcer MD, Brooke LT, Lozano SJ, Vaishnav DD (1991) Sediment quality evaluation in the Lower Fox River and Southern Green Bay of Lake Michigan. Center for Lake Superior Environmental Studies, University of Wisconsin-Superior, Superior, WI, 270 pp
- Canfield TJ, Brunson EL, Dwyer FJ, Ingersoll CG, Kemble NE (1998) Assessing sediments from the upper Mississippi River navigational pools using benthic invertebrates and the sediment quality triad. *Arch Environ Contam Toxicol* 35:202–212
- CCME (Canadian Council of Ministers of the Environment) (1995) Protocol for the derivation of Canadian sediment quality guidelines for the protection of aquatic life. Prepared by the Technical Secretariat of the CCME Task Group on Water Quality Guidelines, Ottawa
- Cubbage J, Batts D, Briedenbach S (1997) Creation and analysis of freshwater sediment quality values in Washington State. Environmental Investigations and Laboratory Services Program, Washington Department of Ecology, Olympia, WA
- Dickson KL, Waller WT, Kennedy JH, Arnold WR, Desmond WP, Dyer SD, Hall JF, Knight JT, Malas D, Martinez ML, Matzner SL (1989) A water quality and ecological survey on the Trinity River, vol. 1 and 2. Institute of Applied Sciences, University of North Texas, University of Texas, Dallas, TX
- Di Toro DM, Mahony JD, Hansen DJ, Scott KJ, Hicks MB, Mayr SM, Redmond MS (1990) Toxicity of cadmium in sediments: the role of acid volatile sulfide. *Environ Toxicol Chem* 9:1487–1502
- Di Toro DM, Zarba CS, Hansen DJ, Berry WJ, Swartz RC, Cowan CE, Pavlou SP, Allen HE, Thomas NA, Paquin PR (1991) Technical basis for establishing sediment quality criteria for non-ionic organic chemicals using equilibrium partitioning. *Environ Toxicol Chem* 10:1541–1583
- Dorkin J (1994) Sediment sampling and analysis plan—West Branch Grand Calumet River: 1993 sediment chemistry data summaries. Environmental Science Division, US Environmental Protection Agency, Region V, Chicago, IL
- EC, MENVIQ (Environment Canada and Ministère de l'Environnement du Québec) (1992) Interim criteria for quality assessment of St. Lawrence River sediment. Environment Canada, Ottawa
- Giesy JP, Hoke RA, Zabik MJ (1993) Sediment toxicity assessment in the Grand Calumet River system. Department of Fisheries and Wildlife, Michigan State University, East Lansing, MI
- Hoke RA, Giesy JP, Zabik M, Unger M (1993) Toxicity of sediments and sediment pore waters from the Grand Calumet River—Indiana Harbor, Indiana, area of concern. *Ecotoxicol Environ Safety* 26:86–112
- Ingersoll CG, MacDonald DD (1999) An assessment of sediment injury in the West Branch of the Grand Calumet River, vol. 1. US Geological Survey, Columbia, MO, MacDonald Environmental Sciences Ltd., Ladysmith, British Columbia, 161 pp
- Ingersoll CG, Haverland PS, Brunson EL, Canfield TJ, Dwyer FJ, Henke CE, Kemble NE, Mount DR, Fox RG (1996) Calculation and evaluation of sediment effect concentrations for the amphipod *Hyalella azteca* and the midge *Chironomus riparius*. *J Great Lakes Res* 22:602–623
- Ingersoll CG, Dillon T, Biddinger RG (1997) Methodological uncertainty in sediment ecological risk assessment. In: Ecological risk assessments of contaminated sediment. SETAC Press, Pensacola, FL 389 pp
- Johnson A, Norton D (1988) Screening survey for chemical contaminants and toxicity in sediments at five lower Columbia River ports. Environmental Investigations and Laboratory Services Program, Washington State Department of Ecology, Olympia, WA
- Kane Driscoll S, Landrum PF (1997) Comparison of equilibrium partitioning and critical body residue approaches for predicting toxicity of sediment-associated fluoranthene to freshwater amphipods. *Environ Toxicol Chem* 16:2179–2186
- Kane Driscoll S, Harkey GA, Landrum PF (1997) Accumulation and toxicokinetics of fluoranthene in sediment bioassays with freshwater amphipods. *Environ Toxicol Chem* 16(4):742–753
- Kemble NE, Dwyer FJ, Hardesty DK, Ingersoll CG, Johnson BT,

- MacDonald DD (1999) Evaluation of the toxicity and bioaccumulation of contaminants in sediment samples from Waukegan Harbor, Illinois. US Environmental Protection Agency, Chicago, IL
- Landrum PF, Faust WR, Eadie BJ (1989) Bioavailability and toxicity of a mixture of sediment-associated chlorinated hydrocarbons to the amphipod, *Pontoporeia hoyi*. In: Cowgill UM, Williams LR (eds) Aquatic toxicology and hazard assessment, 12th vol. STP 1027, American Society for Testing and Materials, Philadelphia, PA, pp 315–329
- Landrum PF, Eadie BJ, Faust WR (1991) Toxicokinetics and toxicity of a mixture of sediment-associated polycyclic aromatic hydrocarbons to the amphipod, *Diporeia* sp. Environ Toxicol Chem 10:35–46
- Long ER, Morgan LG (1991) The potential for biological effects of sediment-sorbed contaminants tested in the National Status and Trends Program. NOAA Technical Memorandum NOS OMA 52, National Oceanic and Atmospheric Administration, Seattle, WA, 175 pp + appendices
- Long ER, MacDonald DD (1998) Recommended uses of empirically-derived sediment quality guidelines for marine and estuarine ecosystems. Human Ecol Risk Assess 4:1019–1039
- Long ER, MacDonald DD, Smith SL, Calder FD (1995) Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environ Manage 19: 81–97
- Long ER, Field LJ, MacDonald DD (1998) Predicting toxicity in marine sediments with numerical sediment quality guidelines. Environ Toxicol Chem 17:714–727
- MacDonald DD (1994) Approach to the assessment of sediment quality in Florida coastal waters. Volume 1—Development and evaluation of the sediment quality assessment guidelines. Report prepared for Florida Department of Environmental Protection, Tallahassee, FL
- MacDonald DD (1997) Sediment injury in the Southern California Bight: review of the toxic effects of DDTs and PCBs in sediments. Prepared for National Oceanic and Atmospheric Administration, US Department of Commerce, Long Beach, CA
- MacDonald DD, Smith SL, Wong MP, Murdoch P (1992) The development of Canadian marine environmental quality guidelines. Ecosystem Sciences and Evaluation Directorate, Environment Canada, Ottawa, 32 pp + appendix
- MacDonald DD, Charlish BL, Haines ML, Brydges K (1994) Development and evaluation of an approach to the assessment of sediment quality in Florida coastal waters. Volume 3—Supporting documentation: biological effects database for sediments. Report prepared for Florida Department of Environmental Protection, Tallahassee, FL, 275 pp
- MacDonald DD, Carr RS, Calder FD, Long ER, Ingersoll CG (1996) Development and evaluation of sediment quality guidelines for Florida coastal waters. Ecotoxicology 5:253–278
- MacDonald DD, DiPinto LM, Field J, Ingersoll CG, Long ER, Swartz RC (2000) Development and evaluation of consensus-based sediment effect concentrations for polychlorinated biphenyls (PCBs). Environ Toxicol Chem (in press)
- NYSDEC (New York State Department of Environmental Conservation) (1994) Technical guidance for screening contaminated sediments. Division of Fish and Wildlife, Division of Marine Resources, Albany, NY, 36 pp
- Persaud D, Jaagumagi R, Hayton A (1993) Guidelines for the protection and management of aquatic sediment quality in Ontario. Water Resources Branch, Ontario Ministry of the Environment, Toronto, 27 pp
- Schlekat C, McGee BL, Boward DM, Reinharz E, Velinsky DJ, Wade TL (1994) Biological effects associated with sediment contamination in the Potomac and Anacostia Rivers in the Washington, D.C. area. Estuaries 17:334–344
- Smith SL, MacDonald DD, Keenleyside KA, Ingersoll CG, Field J (1996) A preliminary evaluation of sediment quality assessment values for freshwater ecosystems. J Great Lakes Res 22:624–638
- Suedel BC (1995) Reducing uncertainty in laboratory sediment toxicity tests. API Publication no. 4632, prepared for the American Petroleum Institute, Department of Biology, University of Mississippi, University, MS
- Suedel BC, Rodgers JH (1993) Bioavailability of fluoranthene in freshwater sediment toxicity tests. Environ Toxicol Chem 12:155–165
- Swartz RC (1999) Consensus sediment quality guidelines for PAH mixtures. Environ Toxicol Chem 18:780–787
- Swartz RC, Kemp PF, Schults DW, Lamberson JO (1988) Effects of mixtures of sediment contaminants on the marine infaunal amphipod *Rhepoxynius abronius*. Environ Toxicol Chem 7:1013–1020
- US EPA (United States Environmental Protection Agency) (1992) Sediment classification methods compendium. EPA 823-R-92-006, Office of Water, Washington, DC, 222 pp
- US EPA (United States Environmental Protection Agency) (1993a) Assessment of sediment in the Indiana Harbor area of concern. EPA 905-R96-009, Great Lakes National Program Office, Region V, Chicago, IL
- US EPA (United States Environmental Protection Agency) (1993b) Assessment of sediment in the Saginaw River area of concern. EPA 905-R96-010, Great Lakes National Program Office, Region V, Chicago, IL
- US EPA (United States Environmental Protection Agency) (1993c) Assessment of sediment in the Buffalo River area of concern. EPA 905-R96-009, Great Lakes National Program Office, Region V, Chicago, IL
- US EPA (United States Environmental Protection Agency) (1996a) Calculation and evaluation of sediment effect concentrations for the amphipod *Hyalella azteca* and the midge *Chironomus riparius*. EPA 905-R96-008, Great Lakes National Program Office, Region V, Chicago, IL
- US EPA (United States Environmental Protection Agency) (1996b) Assessment of sediment in the Indiana Harbor area of concern. EPA 905-R96-009, Great Lakes National Program Office, Region V, Chicago, IL
- US EPA (United States Environmental Protection Agency) (1997a) The incidence and severity of sediment contamination in surface waters of the United States. Volume 1: National sediment quality survey. EPA 823-R-97-006, Office of Science and Technology, Washington, DC
- US EPA (United States Environmental Protection Agency) (1997b) An assessment of sediments from the Upper Mississippi River. Final report—June, 1997. EPA 823-R-97-005, Prepared by US Department of the Interior, Columbia, MO
- USFWS (United States Fish and Wildlife Service) (1993) Milltown endangerment assessment project: effects of metal-contaminated sediment, water, and diet on aquatic organisms. NTIS PB93-21592, National Fisheries Contaminant Research Center, Columbia, MO
- Velinsky DJ, Wade TL, Schlekat CE, McGee BL, Presley BJ (1994) Tidal river sediments in the Washington, D.C. area. I. Distribution and sources of trace metals. Estuaries 17:305–320
- Wade TL, Velinsky DJ, Reinharz E, Schlekat CE (1994) Tidal river sediments in the Washington, D.C. area. II. Distribution and sources of organic contaminants. Estuaries 17:321–333
- Zarba CS (1992) Equilibrium partitioning approach. In: Sediment classification methods compendium. EPA 823-R-92-006, Office of Water, US Environmental Protection Agency, Washington, DC

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Screening Quick Reference Tables

These tables were developed for screening purposes only; they do not represent official NOAA policy and do not constitute criteria or clean-up levels. All attempts have been made to ensure accuracy; however, NOAA is not liable for errors. Values are subject to changes as new data become available.

This set of NOAA Screening Quick Reference Tables, or SQUIRTs, presents screening concentrations for inorganic and organic contaminants in various environmental media. Additional reference material, such as guidelines for sample preservation, are also included.

NOAA identifies potential impacts to coastal resources and habitats likely to be affected by hazardous wastes. To screen for substances which may threaten natural resources of concern to NOAA, environmental concentrations are compared to these screening levels. These tables are intended for preliminary screening purposes only; they do not represent official NOAA policy and do not constitute criteria or clean-up levels. NOAA does not endorse their use for any other purposes. Screening levels are reported with the number of significant figures they were originally reported with.

In this new version, column headings link to OR&R's web site where brief descriptions of the benchmark may be found. However, detailed guidance on the recommended application of various screening guidelines is provided in the original sources (listed in each SQUIRT section, with web links for many). Users of the SQUIRT cards are strongly encouraged to review supporting documentation to determine appropriateness for their specific use.

The SQUIRT card set has been re-organized from earlier versions to accommodate expansion. Benchmarks from numerous new sources have been incorporated, and the list of analytes vastly increased. The SQUIRT cards present benchmarks representing different degrees of protectiveness. Multiple benchmarks are also provided in many cases; the user is advised to review the derivation of any particular benchmark before selecting a specific value.

Information is still presented in sections, with *new sections* appearing in this expanded version:

- | | |
|---|---|
| <ul style="list-style-type: none">• Inorganics in Sediment (freshwater and marine)• Inorganics in Water (groundwater and surface water)• Organics in Water and Soil• <i>Toxic Equivalency Factors</i>• Guidelines for Sample Collection & Storage• Analytical Methods for Inorganics | <ul style="list-style-type: none">• Inorganics in Soil• Organics in Sediment• <i>PCB Composition</i>• <i>Composition by Carbon Range</i>• Analytical Methods for Organics |
|---|---|

Footnotes within each SQUIRT section which appear at the bottom of the page are only to aid in deciphering the nature of specific entries. Due to space constraints, notations which relate to the source for individual values are explained at the end of the section. Organic chemicals are now listed alphabetically, without categorization. A few synonyms are provided, but CAS numbers are also presented to aid in identifying and finding specific analytes. Except as noted, all concentrations in the SQUIRT cards are in parts per billion.

For surface water samples, because releases from hazardous waste sites are often continuous and long-term, concentrations are most often compared directly with chronic benchmarks, when available. Groundwater concentrations are also screened against chronic benchmarks. However, suitable site-specific dilution factors should be applied to allow for dilution upon migration and discharge of groundwater to surface water. The SQUIRT cards present U.S. Environmental Protection Agency (EPA) Maximum Contaminant Levels (MCLs), applicable to drinking water sources and secondary MCLs applicable to groundwater, supplemented by values from Canada and the United Nations World Health Organization.

Preference for surface water and groundwater benchmarks is given to U.S. EPA Ambient Water Quality Criteria (AWQC). This is generally followed by Tier II Secondary Acute Values (SAVs) or available standards and guidelines from other regulatory agencies. Tier II SAVs are derived using a similar approach to AWQC, but do not have sufficient supporting data for full criteria calculation. Lowest Observable Effect Levels (LOELs) were originally published by EPA with AWQC. Around 2000, EPA stopped publishing these values, however, LOELs are reproduced here when no other benchmark is available, because in many instances, they formed the basis for state standards.

For many trace elements, AWQC are now expressed in terms of the "dissolved" fraction, which is essentially defined operationally as a filtered fraction. Likewise, the toxicity of many trace elements is related to the water hardness, and the values presented are for a default hardness of 100 mg/L CaCO₃. Equations are provided in the SQUIRT cards to calculate the exact criteria for a given hardness, or, to convert from unfiltered, total concentrations to "dissolved" fractions.



Screening Quick Reference Table for Inorganics in Sediment

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Analyte	FRESHWATER SEDIMENT										MARINE SEDIMENT						
	"Background" ¹	ARCS <i>H. azteca</i> TEL ²	TEC ³	TEL ³	LEL ⁴	PEC ³	PEL ³	SEL ⁴	UET ¹	T ₂₀ ⁵	TEL ⁶	ERL ⁶	T ₅₀ ⁵	PEL ⁶	ERM ⁶	AET ⁷	
Predicted Toxicity Gradient: Increasing																	
Aluminum (%)	Al	0.26%	2.55%														1.8% N
Antimony	Sb	160							3,000 M	630							9,300 E
Arsenic	As	1,100	10,798	9,790	5,900	6,000	33,000	17,000	33,000	17,000 I	7,400	7,240	8,200	20,000	41,600	70,000	35,000 B
Barium	Ba	700															48,000 A
Cadmium	Cd	100-300	583	990	596	600	4,980	3,530	10,000	3,000 I	380	680	1,200	1,400	4,210	9,600	3,000 N
Chromium	Cr	7,000-13,000	36,286	43,400	37,300	26,000	111,000	90,000	110,000	95,000 H	49,000	52,300	81,000	141,000	160,000	370,000	62,000 N
Cobalt	Co	10,000				50,000+											10,000 N
Copper	Cu	10,000-25,000	28,012	31,600	35,700	16,000	149,000	197,000	110,000	86,000 I	32,000	18,700	34,000	94,000	108,000	270,000	390,000 MC
Iron (%)	Fe	0.99-1.8 %	18.84%			2%			4%	4% I							22% N
Lead	Pb	4,000-17,000	37,000	35,800	35,000	31,000	128,000	91,300	250,000	127,000 H	30,000	30,240	46,700	94,000	112,000	218,000	400,000 B
Manganese	Mn	400,000	630,000			460,000			1,100,000	1,100,000 I							260,000 N
Mercury	Hg	4-51		180	174	200	1,060	486	2,000	560 M	140	130	150	480	700	710	410 M
Nickel	Ni	9,900	19,514	22,700	18,000	16,000	48,600	36,000	75,000	43,000 H	15,000	15,900	20,900	47,000	42,800	51,600	110,000 EL
Selenium	Se	290															1,000 A
Silver	Ag	<500				500 +				4,500 H	230	730	1,000	1,100	1,770	3,700	3,100 B
Strontium	Sr	49,000															> 3,400 N
Tin	Sn	5,000										48 *					57,000 N
Vanadium	V	50,000															410,000 I
Zinc	Zn	7,000-38,000	98,000	121,000	123,000	120,000	459,000	315,000	820,000	520,000 M	94,000	124,000	150,000	245,000	271,000	410,000	410,000 I
Lead 210 bq/g dw						0.5 ^			< 9.7 ^								
Polonium 210 bq/g dw						0.6 ^			< 8.7 ^								
Radium 226 bq/g dw						0.1 ^			< 13 ^								
Sulfides									130,000 M								4,500 MO

- Based on SLC approach using sensitive species HC5%, ES&T 2005 39(14):5148-5156.

* - Based upon EQP approach using current AWQC CCC

^ - Based on SLC approach to derive LEL and SEL, Enval Monitor & Ass'tment 2005 110:71-85

+ - Carried over from Open Water disposal Guidelines; treated as if LEL for management decisions.

Bioassay endpoints: M - Microtox; B - Bivalve; E - Echinoderm larvae; O - Oyster larvae;

A - Amphipod; N - Neartnes; L - Larval bioassay; plus, I - Infaunal community impacts

Sources

1 - Buchman, M. 1999. NOAA HAZMAT Report 99-1.

2 - EPA 905-R96-008

3 - Arch ET&C 2000, 39(120)- TEL and PEL are also known as Canadian ISOGs and PELs

4 - Guidelines for the protection and management of aquatic sediment quality in Ontario Aug 1993

5 - ET&C 2002, 21(9)1993-

6 - Ecotox. 1996, 5(4):253-

7 - Chapter 173-204 WAC, 1991/95 as supplemented by WA Dept of Ecology staff with unpublished data.



Screening Quick Reference Table for Inorganics in Soil

These tables were developed for screening purposes only; they do not represent official NOAA policy and do not constitute criteria or clean-up levels. All attempts have been made to ensure accuracy; however, NOAA is not liable for errors. Values are subject to changes as new data become available.

ANALYTE <small>All concentrations in parts per billion dry weight unless specified otherwise</small>	CAS Number	BACKGROUND ¹		DUTCH STANDARDS ²		ECOSL ³				Plants	Microbes ⁴
		Mean	Range	Target	Intervention	Avian	Inverts	Mammals			
Aluminum	7429905	4.70%	0.5- >10%							50,000 a	600,000
Antimony	7440360	480	bd-8,800	3,000	15,000		78,000	142 v		5,000 a	
Arsenic	7440382	5,200	bd-97,000	900 L	55,000	43,000	60,000 a	5,700 v		18,000	100,000
Barium	7440393	440,000	10,000-0.5%	160,000	625,000		330,000	1,040 v		500,000 a	3,000,000
Beryllium	7440417	630	bd-15,000	1,100	30,000 S		40,000	1,060 v		10,000 a	
Boron	7440428	26,000	bd-300,000							500 a	20,000
Bromine	7726956	560	bd-11,000	20,000						10,000 a	
Cadmium	7440439			800	12,000	770	20,000 a	2,22 v		4,000 a	20,000
Chromium III	7440473	< 37,000	1,000-0.2%	< 380 L	< 220,000 L	26,000	<400 a	34,000		< 1,000 a	< 10,000
Chromium VI	18540299	< 37,000		< 380 L	< 220,000 L		400 a	81,000		< 1,000 a	< 10,000
Cobalt	7440484	6,700	bd-70,000	2,400 L	180,000 L	120,000		140 v		13,000	1,000,000
Copper	7440508	17,000	bd-700,000	3,400 L	96,000 L	28,000	50,000 a	5,400 v		70,000	100,000
Cyanide (total complex)	57125			5,000	50,000 (pH>5)			1,330 v			
Cyanide (total free)				1,000	20,000						
Fluorine	7782414	210,000	bd-0.37%	500,000						200,000 a	30,000
Iodine	7553562	750	bd-9,600							4,000 a	
Iron	7439896	1.80%	0.01- >10%								200,000
Lanthanum	7439910	30,000	bd-200,000								50,000
Lead	7439921	16,000	bd-700,000	55,000 L	530,000	11,000	500,000 a	53.7 v		50,000 a	900,000
Lithium	7439932	20,000	bd-140,000							2,000 a	10,000
Manganese	7439965	330,000	bd-0.7%							220,000	100,000
Mercury	7439976	58	bd-4,600	300	10,000	4,300,000	450,000	4,000,000		300 a	30,000
Mercury(methyl)	22967926			37 L	4,000 L		< 100 a v	1.58 v		< 300 a	
Molybdenum	7439987	590	bd-15,000	3,000	190,000 L		100 a v			2,000 a	200,000
Nickel	7440020	13,000	bd-700,000	260 L	100,000 L	210,000	200,000 a	13,600 v		30,000 a	90,000
Selenium	7782492	260	bd-4,300	700 L	100,000 S	1,2000	4,100	630		520	100,000
Silver	7440224				15,000 S	4,200		4,040 v		2,000 a	50,000
Strontium	7440246	120,000	bd-0.3%								
Sulfide	18496258										
Sulfur	7704349	0.12%	bd-4.8%					3.58 v			
Technetium	7440268									200 a	

1. bd – below detection
2. S – serious contamination level; L – Environmental Risk Limit



Screening Quick Reference Table for Inorganics in Soil

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ANALYTE <small>All concentrations in parts per billion dry weight unless specified otherwise</small>	CAS Number	BACKGROUND		DUTCH STANDARDS ²		Eco-SQL ³			
		Mean	Range	Target	Intervention	Avian	Inverts	Mammals	Plants
Tellurium	Te	13,494,809			600,000				
Thallium	Tl	7,440,280	8,600	1,000	15,000 S			56.9 v	1,000 a
Tin	Sn	7,440,315	890	19,000 background	900,000 S			7,620 v	50,000 a
Titanium	Ti	7,440,326	0.224 %		< 2,500				
Tin as Triphenyltin		668,348							
Tungsten	W	7,440,337							
Uranium	U	7,440,611	2,300	290-11,000					5,000 a
Vanadium	V	7,440,622	58,000	42,000	250,000 S	7,800		1,590 v	2,000 a
Zinc	Zn	7,440,666	48,000	16,000 L	350,000 L	46,000	6,620 v		50,000 a
									100,000

Sources

- 1 - USGS Prof. Paper 1270. 1984. Mean is geometric mean of national data.
- 2 - Entry is lower of current VROM Environmental Quality standards or the updated RIVM Environmental Risk Limits. Risk limits are typically divided by 100 to derive the Target value; this computation has not been done here.
Dutch Target/Intervention: E.M.J. Verbruggen, R. Posthumus and A.P. van Wezel. 2001. Ecotoxicological Serious Risk Concentrations for soil, sediment, and (ground)water. Updated proposal for first series of compounds. Nat. Inst. Public Health and the Env., and subsequent updates as published elsewhere.
Min. Housing, Spatial Plan. And the Env., 2000. Annexes Circular on target values and intervention values for soil remediations.
- 3 - Entry is lower of either:
EPA Eco-SQLs, www.epa.gov/ecotox/ecosql/
a - ORNL Screening benchmark for earthworms and soil microorganisms: ORNL 1997a, ES/ERTM-126/R2
v - EPA R5 Eco Screening levels soil - shrew or vole, www.epa.gov/reg5crical/
- 4 - ORNL 1997b, ES/ERTM-85/R3.

1. bd - below detection
2. S - serious contamination level, L - Environmental Risk Limit



Screening Quick Reference Table for Inorganics in Water

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E L E M E N T All concentrations in parts per billion unless specified otherwise		G R O U N D W A T E R ¹		S U R F A C E W A T E R S ²			
				Freshwater		Marine	
				Acute	Chronic	Acute	Chronic
Aluminum	Al	50-200 *	pH 750	pH 87	1,500 p	500 p	
Antimony	Sb	6	88 p	30 p		2.3 nZ	
Arsenic III	As ³⁺	<10		190 E			
Arsenic V	As ⁵⁺	<10	66 T	3.1 T	2,319 *		
Arsenic, Total	As	10	340	150	69	36	
Barium	Ba	2,000	110 T	3.9 E	1,000 BC	200 BC	
Beryllium	Be	4	35 T	0.66 T	1,500 BC	100 BC	
Boron	B	5,000 C	30 T	1.6 T		1,200	
Cadmium	Cd	5	2.0 †	0.25 †	40	8.8	
Chromium III	Cr ³⁺	<100	570 †	74 †	10,300 *	27.4 nZ	
Chromium VI	Cr ⁶⁺	<100	16	11	1,100	50	
Chromium, Total	Cr	100					
Cobalt	Co		1,500 T	3.0 E		1 nZ	
Copper	Cu	1,300	13 †	9 †	4.8	3.1	
Fluoride	F	4,000	200 BC (hardness < 50)		1,500 BC		
Gallium	Ga						
Iron	Fe	300 *		18 nZ	300 BC	use 18 nZ	
Lanthium	La			1,000		50 BC	
Lead	Pb	15	65 †	0.04 nZ	210	8.1	
Lithium	Li		260 T	2.5 †			
Manganese	Mn	50 *	2,300 T	14 T		100 BC	
Mercury	Hg	2	1.4	80 E	1.8	0.94	
Methyl Mercury			0.099 T	0.0028 T			
Molybdenum	Mo	70 W	16,000 T	34 nZ		23 nZ	
Nickel	Ni	20 W	470 †	52 †	74	8.2	
Phosphorus	P					0.1	
Potassium	K		373,000 BC				
Selenium	Se	50	13-186 total	5 total	290	71	
Silver	Ag	100 *	1.6 (½) †	0.36 T	0.95 (½)		
Strontium	Sr		15,000 T	1,500 T			
Thallium	Tl	2	110 T	0.03 nZ	2,130 *	17 nZ	
Tin as TBT	Ti		0.46	0.072	0.42	0.0074	

1. * - Secondary standard
2. pH - criteria is pH dependent p - proposed t - hardness dependent * - EPA LOEL (½) - CMC is halved to compare to 1985 Guideline derivation



Screening Quick Reference Table for Inorganics in Water

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E L E M E N T All concentrations in parts per billion unless specified otherwise	G R O U N D W A T E R ¹	S U R F A C E W A T E R S ²			
		F r e s h w a t e r		M a r i n e	
		Acute	Chronic	Acute	Chronic
Tin as Di-N-Buryl		0.08 BC			
Tin as Triethyl		0.4 BC		34 BC	
Tin as Triphenyl		0.022 BC			
Titanium	Ti	2,000 BC			
Uranium	U	46 T	0.5 NZ	500 BC	100 BC
Vanadium	V	280 T	19 E		50 BC
Zinc (Zn)	Zn	120 T	120 T	90	81
Zirconium	Zr	310 T	17 T		
Hydrogen Sulfide		2		2	
Cyanide, free	CN	22	5.2	1	1

Freshwater criterion for certain elements (T) are expressed as a function of hardness (mg/L) in the water column. The values shown assume 100 mg/L. Values for a different hardness may be calculated using the following equations to arrive at a CMC or CCC for filtered samples. Hardness may range up to 400 mg/L as calcium carbonate. For hardness above this range, use 400 mg/L as the maximum value allowed. For salinity between 1 and 10 ppt, use the more stringent of either fresh or marine values.

Sources

- 1 – Primary entry is the US EPA MCL value, followed by the WHO drinking water guidelines.
Maximum Contaminant Levels (MCLs): <http://www.epa.gov/safewater/index.html>
W – World Health Organization's (WHO) Drinking water guidelines: http://www.who.int/water_sanitation_health/dwg/en/
C – Canadian water Quality Guidelines: <http://www.ec.gc.ca/CEQG-RCQE/English/Ceqg/Water/default.cfm>
- 2 – Primary entry is the US Ambient Water Quality Criteria, followed by the lowest of Tier II SAVs or available standards and guidelines.
EPA Ambient water Quality Criteria (AWQC): <http://www.epa.gov/waterscience/criteria/aqlife.html>
T – Tier II Secondary Acute Value: <http://www.esd.cornell.gov/programs/ecorisk/tools.html>
BC – British Columbia Water Quality Guidelines (either working or recommended): <http://www.env.gov.bc.ca/wat/wq/>
NZ – Australian & New Zealand ECIs and Trigger values: ANZECC Oct 2000, Volume 1, The Guidelines. [www.mfe.govt.nz/publications/E-EcoUpdate:](http://www.mfe.govt.nz/publications/E-EcoUpdate/) www.epa.gov/oswer/riskassessment/ecoup/

Lowest Observable Effect Levels (LOELs) previously published by EPA are also included since these essentially were the basis for many state standards. EPA LOELs: EPA Water quality Criteria Summary, Office of Science & Technology, Health & Ecological Criteria Div., Ecological Risk Assessment Branch, 1991. Full listings appeared in various Fed. Register notices and in EPA's Quality Criteria for Water, 1992.

1 – Secondary standard
2 – pH – criteria is pH dependent p – proposed; t – hardness dependent; * – EPA LOEL; (1/2) – CMC is halved to compare to 1985 Guideline derivation



Screening Quick Reference Table for Inorganics in Water

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ELEMENT	HARDNESS CALCULATIONS – UNFILTERED FRESHWATER CRITERIA		UNFILTERED TO FILTERED CALCULATIONS			
	CMC	CCC	Fresh water CMC		Freshwater CCC	
			1	1	1	1
Arsenic (As)						
Cadmium (Cd)	$CMC = e^{1.0166 [ln(hardness)] - 3.924}$	$CCC = e^{0.7409 [ln(hardness)] - 4.719}$	$CF = 1.13672 - 0.041838 [ln(hardness)]$	$CF = 1.101672 - 0.041838 [ln(hardness)]$	$CF = 0.994$	
Chromium III (Cr+3)	$CMC = e^{0.819 [ln(hardness)] + 3.7256}$	$CCC = e^{0.819 [ln(hardness)] + 0.6848}$	$CF = 0.316$	$CF = 0.860$	–	
Chromium VI (Cr +6)			$CF = 0.982$	$CF = 0.962$	$CF = 0.993$	
Copper (Cu)	$CMC = e^{0.9422 [ln(hardness)] - 1.7}$	$CCC = e^{0.8545 [ln(hardness)] - 1.702}$	$CF = 0.960$	$CF = 0.960$	$CF = 0.83$	
Lead (Pb)	$CMC = e^{1.273 [ln(hardness)] - 1.46}$	$CCC = e^{1.273 [ln(hardness)] - 4.705}$	$CF = 1.46203 - 0.145712 [ln(hardness)]$	SAME AS CMC	$CF = 0.951$	
Mercury (Hg)			$CF = 0.85$	$CF = 0.85$	$CF = 0.85$	
Nickel (Ni)	$CMC = e^{0.846 [ln(hardness)] + 2.255}$	$CCC = e^{0.846 [ln(hardness)] + 0.0584}$	$CF = 0.998$	$CF = 0.997$	$CF = 0.990$	
Selenium (Se)			–	–	$CF = 0.998$	
Silver (Ag)	$CMC = e^{1.72 [ln(hardness)] - 6.52}$	CCC – No criteria	$CF = 0.85$	–	$CF = 0.85 / –$	
Zinc (Zn)	$CMC = e^{0.8473 [ln(hardness)] + 0.884}$	$CCC = e^{0.8473 [ln(hardness)] + 0.884}$	$CF = 0.978$	$CF = 0.986$	$CF = 0.946$	

Freshwater criterion for certain elements are expressed as a function of hardness (mg/L) in the water column. The values shown assume 100 mg/L. Values for a different hardness may be calculated using the above equations to arrive at a CMC or CCC for *filtered* samples. Hardness may range up to 400 mg/L as calcium carbonate. For hardness above this range, use 400 mg/L as the maximum value allowed.

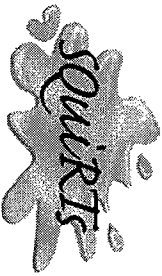
Criteria for most metals are expressed as standards for samples filtered through 0.45 m filter (i.e., "dissolved"). To convert unfiltered concentrations to filtered, multiply the unfiltered concentration value by the appropriate Conversion Factor (CF) above. For cadmium and lead, the conversion factor itself is hardness-dependent.

CMC: Criteria Maximum Concentration is the highest level for a 1-hour average exposure not to be exceeded more than once every three years, and is synonymous with "acute."

CCC: for a 4-day average exposure not to be exceeded more than once every three years, and is synonymous with "chronic."

Sources

EPA Ambient water Quality Criteria (AWQC): <http://www.epa.gov/waterscience/criteria/aqlife.html>



Screening Quick Reference Tables for Organics – Sediment

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ANALYTE All concentrations in parts per billion dry weight unless specified otherwise	CAS Number	FRESHWATER SEDIMENT						DUTCH Sediments		MARINE SEDIMENT						Eco Tox Edp 3 @1%TOC			
		ARCS Hyalella TEL	TEL 2	IEC 2	TEL 3	PEL 2	PEC 2	SEL 3	UET 4 @1%TOC	Target	Intervention	TEL 6	TEL 7	ERL 7	TEL 8		PEL 7	ERM 7	AEI 8
2,3,7,8-TCDD dioxin TEOS	1746016		0.00085 c			0.0215 c			0.0088TH	1 S		19	0.00085 c	16	116	0.0215 c	500	0.0036 N	
Acenaphthene	83329		6.71 c			88.9 c			290 M			14	6.71	44	140	88.9	640	130 E	
Acenaphthylene	208968		5.87 c			128 c			160 M							128		71 E	
Acrylonitrile	107131				2			80	40 I	0.07	100 S							9.5 AE	
Aldrin + Dieldrin + Endrin	na									0.06	1,700 LB								
Anthracene	120127	10	46.9 c	57.2	220	245 c	845	3,700	260 M	39 LB	1,600 LB	34	46.9	85.3	290	245	1,100	280 E	
Atrazine	1912249									0.2	710 LB								
BCH compounds (sum)	na									10	6,400 L								
Benz[a]anthracene	56553	15.72	31.7	108	320	385	1,050	14,800	500 I	25 L	2,500 L	61	74.8	261	466	693	1,600	960 E	
Benzene	71432									10	1,000								57
Benzo[ghi]perylene	191242				170			3,200	300 M	570 LB	33,000 LB	67			497			670 M	
Benzo[a]pyrene	50328	32.4	31.9	150	370	782	1,450	14,400	700 I	52 L	7,000 L	69	88.8	430	520	763	1,600	1,100 E	
Benzo[b]fluoranthene	205992											130			1,107			1,800 E I	
Benzo[k]fluoranthene	207089	27.2			240			13,400	13,400B	380 LB	38,000 LB	70			537			1,800 E I	
Benzoic acid	65850																	65 O	
Benzyl alcohol	100516																	52 B	
BHC, alpha (α-HCH)	319846				6			100		3	< 2,000								
BHC, beta (β-HCH)	319857				5			210		9	< 2,000								
BHC, delta (δ-HCH)	319868									< 10	< 2,000								
BHC, gamma- (γ-HCH; Lindane)	58899		0.94	2.37	3	1.38	4.99	10	9 I	0.05	1,200 L		0.32		73	0.99		> 4.8 N	3.7
Biphenyl	92524											17							1,100
Bis(2-ethylhexyl)phthalate (DEHP)	117817								750 TM	< 100	10,000 LB		182			2647		1,300 I	
Bromoform (Tribromomethane)	75252										75,000								650
Butanol	35296721																		
Butyl acetate, 1- or 2-	na																		
Butyl benzyl phthalate	85687									< 100								63 M	1,100
Carbaryl	63252									0.03	450 LB								
Carbofuran	1563662									0.02	17 LB								
Carbon tetrachloride	56235									170 LB	1,000								1,200
Tetrachloromethane; Tetra																			

4. Entry is lowest, reliable value among AET tests; on 1% TOC basis: I - Infaunal community impact; M - Microtox bioassay; H - *Hyalella azteca* bioassay; T - value on dry weight basis.
 5. S - Serious Contamination; L - Environmental Risk Limit for soil; LB - Environmental Risk Limit for soil or bedded sediment
 8. Entry is lowest value among AET tests: I - Infaunal community impact; A - Amphipod; B - Bivalve; M - Microtox bioassay; O - Oyster larvae; E - Echinoderm larvae; L - Larval max; or, N - *Neomysis* bioassay.



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ANALYTE	CAS Number	FRESHWATER SEDIMENT							DUTCH Sediments		MARINE SEDIMENT							Eco Tox Eqp ⁹ @1%TOC			
		ARCS Hyalella TEL ¹	TEL ²	IEC ²	TEL ³	PEL ²	PEC ²	SEL ³	UET ⁴ @1%TOC	Target	Intervention	TEL ⁶	TEL ⁷	ERL ⁷	TEL ⁶	PEL ⁷	ERM ⁷		AET ⁸		
Catechol (o-Dihydroxybenzene)	120809			4.5	3.24	7	8.9	17.6	60	30.1	3.2 LB 0.03	2,600 LB 4,000			2.26	0.5		4.79	6	2.8 A	820
Chlordane	57749										<0.03	<4,000									
Chlordane (alpha)	5103719										<0.03	<4,000									
Chlordane (gamma)	5103742										<0.03	<4,000									
Chloro, 4-2-methyl phenol	1570645										<15,000 S	<15,000 S									
Chloro, 4-2-methylphenoxy acetic acid (MCPA)	94746										0.05	4,000									
Chloro, 4-3-methyl phenol	59507										<15,000 S	<15,000 S									
Chloro, 4-methyl phenols	na										5	15,000 S									
Chloroaniline	27134265										30	50,000									
Chlorobenzenes (sum)	na										20	30,000									
Chloroform (trichloromethane)	67663										57 LB	<10,000									
Chloronaphthalene, 1-	90131										250 LB	<10,000									
Chloronaphthalene, 2-	91587										55 LB	7,800 LB								0.333	
Chlorophenol, 2-	95578										35 L	14,000 L									
Chlorophenol, 3-	108430										20 LB	1,400 LB									
Chlorophenol, 4-	106489										10	10,000									
Chlorophenols (sum)	na																				
Chrysene	218019	26.83	57.1	166	340	862	1,290	4,600	800 I	8,100 LB	35,000 LB	82	108	384	650	846	2,800	950 E			
Cresol [m-] (3-Methyl phenol)	108394										1,600 L	16,000 L									
Cresol [o-] (2-Methyl phenol)	95487										500 L	50,000 L						8 B			
Cresol [p-] (4-Methyl phenol)	106445										5.1 LB	2,600 LB						100 B			
Cresols, sum	1319773										50	5,000									
Cyclohexanone	108941										100	45,000									
DDD, 4,4- (p,p-DDD, TDE)	72548		3.54	4.88	8	8.51	28	60	<60.1	3.9 LB	34,000 LB		1.22	2			7.81	20	<16.1		
DDE, 4,4- (p,p-DDE)	72559		1.42	3.16	5	6.75	31.3	190	<50.1	5.8 LB	1,300 LB		2.07	2.2			374	27	<9.1		
DDT, 4,4- (p,p-DDT)	50293		1.19 c	4.16	8	4.77 c	62.9	710	50.1	9.8 LB	1,000 L		1.19	1			4.77	7	<12 E		
DDT+DDE+DDD (sum)	na		7	5.28	7	4.450	572	120	50.1	10	4,000		3.89	1.58			51.7	46.1	11 B		
Diazinon	333415																			1.9	
Dibenz[ah]anthracene	53703																			230 OM	
Dibenzofuran	132649	10	6.22 c	33	60	135 c		1,300	100 M			19	6.22	63.4	113	135	260	230 OM	110 E	2,000	

4. Entry is lowest, reliable value among AET tests; on 1% TOC basis: I - Infaunal community impact; M - Microtox bioassay; H - Hyalella azteca bioassay; T - value on dry weight basis.
 5. S - Serious Contamination; L - Environmental Risk Limit for soil; LB - Environmental Risk Limit for soil or bedded sediment
 8. Entry is lowest value among AET tests: I - Infaunal community impact; A - Amphipod; B - Bivalve; W - Microtox bioassay; O - Oyster larvae; E - Echinoderm larvae; L - Larval max; or, N - Neanthes bioassay.



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ANALYTE <small>All concentrations in parts per billion dry weight unless specified otherwise</small>	CAS Number	FRESHWATER SEDIMENT						DUTCH Sediments ⁵		MARINE SEDIMENT						Eco Tox Exp ⁹ @1%TOC			
		ARCS <i>Hyalella</i> TEL ¹	TEL ²	TEC ²	TEL ³	PEL ²	PEC ²	SEL ³	UET ⁴ @1%TOC	Target	Intervention	TEL ⁶	TEL ⁷	ERL ⁷	TEL ⁶		PEL ⁷	ERM ⁷	AEL ⁸
Dichloroaniline, 2,4-	554007									< 5	< 50,000 S								
Dichloroaniline, 3,4-	95761									< 5	< 50,000 S								
Dichloroaniline, 3,4-	95761									< 5	< 50,000 S								
Dichlorobenzene, 1,2-	95501									< 30	17,000 LB							13 N	340
Dichlorobenzene, 1,3-	541731									< 30	24,000 LB							1700	
Dichlorobenzene, 1,4-	106467									< 30	18,000 LB							110 IM	350
Dichlorobenzenes	25321226									< 30	19,000 LB								
Dichloroethane, 1,1-	75343									20	15,000								
Dichloroethane, 1,2-	107062									20	4,000								
Dichloroethane, 1,1- (vinylidene chloride)	75354									100	300								
Dichloroethene, 1,2- (cis or trans)	540590									200	1,000							0.2083	
Dichlorophenol, 2,4-	120832									< 10	8,400 LB								
Dichlorophenol, 2,6-	87650									< 10	57,000 LB								
Dichlorophenol, 3,4-	95772									< 10	57,000 LB								
Dichlorophenol, 3,5-	591355									< 10	5,400 LB								
Dichlorophenols (sum)	na									< 10	22,000 LB								
Dichloropropane, 1,2- (propylene dichloride)	78875									< 2	< 2,000								
Dieldrin †	60571		2.85	1.9	2	6.67	61.8	910	300 I	0.5	1,900 LB	0.83	0.72	0.02	2.9	4.3	8	1.9 E	
Diethyl phthalate	84662									530 L	53,000 L							6 BL	630
Diethylene-glycol	111466										270,000 S								
Dihydroxybenzenes, sum	na									62 LB	8,000 LB								
Di-iso-butyl phthalate	84695									92 LB	17,000 LB								
Dimethyl phthalate	131113									1,000 LB	84,000 LB							6 B	
Dimethylnaphthalene, 2,6-	581420											25			133			18 N	
Dimethylphenol, 2,4-	105679																	58 BL	11,000
Di-n-butyl phthalate	84742								110 H	7,000 LB	36,000 LB							61 BL	
Di-n-octyl phthalate	117840									< 100	< 60,000								
Dodecylbenzene	25155300										1,000,000 S								
Endosulfan (a or b)	115297									0.01	4,000							2.9 α 14 β	

- Entry is lowest, reliable value among AET tests, on 1% TOC basis. I - Infaunal community impact; M - Microtox bioassay; H - *Hyalella azteca* bioassay; † - value on dry weight basis.
- S - Serious Contamination; L - Environmental Risk Limit for soil; LB - Environmental Risk Limit for soil or bedded sediment.
- Entry is lowest value among AET tests: I - Infaunal community impact; A - Amphipod; B - Bivalve; M - Microtox bioassay; O - Oyster larvae; E - Echinoderm larvae; L - Larval; or N - *Neatriches* bioassay.



Screening Quick Reference Tables for Organics – Sediment

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ANALYTE All concentrations in parts per billion dry weight unless specified otherwise	CAS Number	FRESHWATER SEDIMENT						DUTCH Sediments ⁵		MARINE SEDIMENT						Eco Tox Eqp ³ @%TOC				
		ARCS <i>Hyalella</i> TEL	TEL ²	TEC ²	TEL ³	PEL ²	PEC ²	SEL ³	UET ⁴ @%TOC	Target	Intervention	TEL ⁵	TEL ⁷	ERL ⁷	TEL ⁵		PEL ⁷	ERM ⁷	AEL ⁸	
Endosulfan II	33213659																			
Endrin	72208		2.67	2.22	3	62.4	207	1,300	500 I	0.04	95 L									
Ethyl acetate	141786										75,000 S									
Ethyl acetate	141786										75,000 S									
Ethyl Benzene	100414									30	50,000									4 EL
Ethylene glycol	107211										100,000 S									3,600
Fluoranthene	206440	31.46	111	423	750	2,355	2,230	10,200	1,500 M	1,000 LB	260,000	119	113	600	1,034	1,494	5,100	1,300 E		
Fluorene	86737	10	21.2 c	77.4	190	144 c	536	1,600	300 M		100 S	19	21.2	19	114	144	540	120 E		540
Formaldehyde	50000																			
Guthion (Azinphos-methyl)	865000																			
Heptachlor	76448																			
Heptachlor epoxide	1024573		0.6	2.47	5	2.74	16	50	10 I	0.005	2,000 S	0.6 c						0.3 B		
Hexachlorobenzene	118741				20			240	100 I	0.7	4,000							6 B		
Hexachlorobutadiene (HCBD)	87683									0.0002	4,000							1.3 E		
Hexachlorocyclohexane (BHC)	608731				3			120	100 I		2,000 LB									
Hexachloroethane	67721																			
Hydroquinone (p-dihydroxybenzene)	123319																			1,000
Indeno[1,2,3-cd]pyrene	193395	17.32			200			3,200	330 M	50	43,000 LB	68						73 BL		
Linear alkylbenzene sulfonates (LAS)	na									31 LB	1,900 LB							600 M		
Malathion	121755																			
Maneb	12427382									2	22,000 L	<12,800 €								0.67
Methanol	67561										30,000 S									
Methoxychlor	72435										35,000 S									19
Methyl ethyl ketone (MEK, 2-Butanone)	78933																			
Methyl naphthalene, 2-	91576																			
Methylene chloride (Dichloromethane, DCM)	75092									18 LB	3,900 L									
Methylnaphthalene, 1-	90120																			
Methylphenanthrene, 1-	832699																			
Methyl-tert-butyl ether (MTBE)	1634044										100,000 S									
Mirex	2365855				7			1,300	800 I											

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5. S - Serious Contamination; L - Environmental Risk Limit for soil; LB - Environmental Risk Limit for soil or bedded sediment.
8. Entry is lowest value among AET tests: I - Infaunal community impact; A - Amphipod; B - Bivalve; M - Microtox bioassay; O - Oyster larvae; E - Echinoderm larvae; L - Larval max; or N - *Neantides* bioassay.



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ANALYTE All concentrations in parts per billion, dry weight unless specified otherwise	CAS Number	FRESHWATER SEDIMENT						DUTCH Sediments		MARINE SEDIMENT						Eco Tox EqP ⁹ @1%TOC				
		ARCS Hydrelia TEL ¹	TEL ²	IEC ²	TEL ³	PEL ²	PEC ²	SEL ³	UET ⁴ @1%TOC	Target	Intervention	TEL ⁶	TEL ⁷	ERL ⁷	TEL ⁸		PEL ⁷	ERM ⁷	AET ⁸	
Monochloroaniline (3 isomers)	na									5	50,000									820
Monochlorobenzenes	108907									< 30	15,000 LB									
Monochloronaphthalenes	na									120 LB	10,000									
Monochlorophenols (sum)	na									< 10	5,400 L									
Naphthalene	91203	14.65	34.6 c	176		391 c	561		600 I	120 LB	17,000 LB	30	34.6	160	217	391	2,100	230 E	480	
Nitrobenzene	98953																	21 N		
Nitrosodiphenylamine, N-Nonylphenol	86306																	28 I		
PAHs, Low MW	25154523		1,400 c						5,300 M	< 1,000	< 40,000		1,000 c	552		1,442	3,160	1,200 E		
PAHs, High MW	na								6,500 M	< 1,000	< 40,000		312	655	1,700	6,676	9,600	7,900 E		
PAHs, Total	na	264.1							12,000 M	1,000	40,000		1,684	4,022		16,770	44,792			
PCB 105	32598144									1.5 LB	< 1,000									
PCB 126	57465288									0.0025 LB	920 LB									
PCB 77	32598131									0.42 LB	< 1,00									
PCB-Aroclor 1254	na		60 c		60	340 c		340		0.3 LB	1,000	35	63.3 c			709 c	180	130 M		
PCBs (sum)	1336363	31.62	34.1	59.8	70	277	676	5,300	26 M				21.6	22.7	368	189				
Pentachloroaniline	527208									15 LB	16,000 LB									
Pentachlorobenzene	608935									< 10	8,000 LB									
Pentachlorophenol [PCP: at pH 7.8†]	87865											74			453			17 B	690	
Perylene	198550																			
Phenanthrene	85018	18.73	41.9	204	560	515	1,170	9,500	800 I	3,300 LB	31,000 LB	68	86.7	240	455	544	1500	660 E		
Phenol	108952								48 † H	50	14,000 LB							130 E		
Phthalates (sum)	na									100	60,000									
Propanol, 2- (Isopropanol)	67630										220,000 S									
Pyrene	129000	44.27	53	195	490	875	1,520	8,500	1,000 I			125	153	665	932	1,398	2,600	2,400 E		
Pyridine	110861									100	500									
Resorcinol (m-dihydroxybenzene)	108463									34 LB	4,600 LB									
Styrene (Vinyl benzene)	100425									200 LB	86,000 LB									
Tetrachloroaniline, 2,3,5,6-	3481207									< 30,000 S										
Tetrachlorobenzene, 1,2,3,4-	634662									160 L	16,000 L									
Tetrachlorobenzene, 1,2,3,5-	634902									6.5 L	650 L									

4. Entry is lowest, reliable value among AET tests, on 1% TOC basis: I - Infaunal community impact; M - Microtox bioassay; H - *Hydrelia azteca* bioassay; † - value on dry weight basis.
 5. S - Serious Contamination; L - Environmental Risk Limit for soil; LB - Environmental Risk Limit for soil or bedded sediment
 8. Entry is lowest value among AET tests: I - Infaunal community impact; A - Amphipod; B - Bivalve; M - Microtox bioassay; O - Oyster larvae; E - Echinoderm larvae; L - Larval; na - or; N - *Neartnes* bioassay.



Screening Quick Reference Tables for Organics – Sediment

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ANALYTE <small>All concentrations in parts per billion dry weight unless specified otherwise</small>	CAS Number	FRESHWATER SEDIMENT						DUTCH Sediments ⁵	MARINE SEDIMENT						Eco Tox EqP ⁹ @1%TOC				
		ARCS <i>Hyalella</i> TEL ³	TEL ²	TEC ²	TEL ³	PEL ²	PEC ²		SEL ³	UET ⁴ @1%TOC	Target	Intervention	TEL ⁶	TEL ⁷		ERL ⁷	TEL ⁸	PEL ⁷	ERM ⁷
Tetrachlorobenzene, 1,2,4,5-	95943								10 L	1,000 L								57 I	530
Tetrachlorobenzenes	na								22 L	2,200 L									
Tetrachloroethylene (Tetrachloroethene; PCE; PER)	127184								2	4,000									
Tetrachlorophenol, 2,3,4,5-	4901513								< 10	< 10,000									
Tetrachlorophenol, 2,3,4,6-	58902								< 10	< 10,000									
Tetrachlorophenols (sum)	25167833								< 10	< 10,000									
Tetrahydrofuran	109999								100	2,000									
Tetrahydrothiophene	110010								100	8,800 LB									
Toluene	108883								100	47,000 L									670
Toxaphene	8001352								10										28
Tributyltin oxide	56359								< 10	< 2,500									
Trichloroaniline (multiple isomers)	na									10,000 S									
Trichloroaniline, 2,4,5-	636306								< 11 L	< 10,000 S								> 4.8 E	9,200
Trichlorobenzene, 1,2,3-	87616								11 LB	5,100 LB									
Trichlorobenzene, 1,2,4-	120821								38 L	11,000 L									
Trichlorobenzenes	12002481								70	15,000									170
Trichloroethane, 1,1,1-	71556								400	10,000									
Trichloroethane, 1,1,2-	79005								7.8 L	2,500 L								41 N	1,600
Trichloroethene (TCE)	na								< 10	4,500 L									
Trichlorophenol, 2,3,5-	95954								< 10	22,000 LB								31	
Trichlorophenol, 2,4,5-	88062								< 10	110,000 LB								61	
Trichlorophenol, 2,4,6-	na								< 10	22,000 L									
Trichlorophenols, (sum)	na								10	100									
Vinyl chloride	75014								130 LB	17,000 LB								4 BL	
Xylene	1330207								110 LB	18,000 LB									25
Xylene, m-	108383								89 LB	9,300 LB									
Xylene, o-	95476																		

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5. S - Serious Contamination; L - Environmental Risk Limit for soil; LB - Environmental Risk Limit for soil or bedded sediment
8. Entry is lowest value among AET tests: I - Infaunal community impact; A - Amphipod; B - Bivalve; M - Microtox bioassay; O - Oyster larvae; E - Echinoderm larvae; L - Larval_{max}; or, N - *Neantides* bioassay.



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Sources

- 1 – Assessment & Remediation of Contaminated Sediments (ARCS) Program, Sept 1996. EPA 905-R96-008.
- 2 – MacDonald et al, 2000. Arch ET&C 39(1):20-
C – Canadian Sediment Quality Guidelines for the Protection of Aquatic Life, Summary Tables Update 2002, www.cerne.ca/publications/ceeqg_rceqg.html
- 3 – Persuad 1993. Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario. Thompson et al, 2005. Enval Monitor & Assessment 110:71-
- 4 – Buchman 1999. NOAA HAZMAT Report 99-1.
- 5 – Entry is lower of current VROM Environmental Quality standards or the updated RIVM Environmental Risk Limits. Risk limits are typically divided by 100 to derive the Target value; this computation has not been done here. Dutch Target/Intervention: E.M.J. Verbruggen, R. Posthumus and A.P. van Wezel, 2001. Ecotoxicological Serious Risk Concentrations for soil, sediment, and (ground)water: updated proposal for first series of compounds. Min. Housing, Spatial Plan. And the Env., 2000. Annexes Circular on target values and intervention values for soil remediations.
- 6 – Field et al, 2002. ET&C 21:1993-
- 7 – MacDonald et al, 1996. Ecotox. 5(4):253-
C – Canadian Sediment Quality Guidelines for the Protection of Aquatic Life, Summary Tables Update 2002, www.cerne.ca/publications/ceeqg_rceqg.html
€ - DeValls et al, 1999. Ecotox. & Env Rest 2(1):34-
- 8 – Wash Dept Ecol Publ 95-308, 1995 and 97-323a, 1997
Giles & Waldrow Puget Sound Dredged Disposal Analysis Rept 1996. <http://www.ecy.wa.gov/biblio/wac173204.html>
plus unpublished information.
- 9 – EcoUpdate EcoTox Thresholds, <http://www.epa.gov/oswer/riskassessment/>
- 4 – Entry is lowest, reliable value among AET tests: on 1% TOC basis: I - Infaunal community impact; M - Microtox bioassay; H - *Hyalella azteca* bioassay; T - value on dry weight basis.
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Screening Quick Reference Tables for Organic in Water and Soil

ANALYTE <small>All concentrations in parts per billion unless specified otherwise</small>	CAS Number	GROUND WATER			SURFACE WATERS				SOIL		
		Target Dutch Intervention	MCL ²	Acute ³	Fresh Chronic ³	Marine Acute ³	Marine Chronic ³	Invertebrates ⁴	Mammals ⁵	Plants ⁶	Other ⁷
2,3,7,8-TCDD (dioxin TEQs)	1746016			<0.01 *	<0.00001 *				0.000199		
2,4,5-Trichlorophenoxyacetic acid (2,4,5-T)	93765				36 NZ				596		
2,4-Dichlorophenoxyacetic acid (2,4-D)	94757				4.0 CA				27.2		
Acenaphthene	83329		9 W	1,700 *	5.8 CA	970 *	40 Eco		682,000	20,000	
Acenaphthylene	208968				4,840 V	300 *C			682,000		
Acetone	67641			28,000 T	1,500 T				2,500		
Acetonitrile	75058				160 NZ				1,370		
Acetophenone	98862								300,000		
Acetylaminofluorene, 2-	53963								596		
Acridine	260946			68 *	4.4 CA						
Acrolein	107028			7,550 *	0.01 NZ	55 *	0.1 NZ		5,270		1,000,000 M
Acrylonitrile	107131	0.08	5 S		2,600 *				23.9		0.007 D
Alcohol ethoxylated surfactants (AE)	na				140 NZ						
Alcohol ethoxylated sulfate (AES)	na				650 NZ						
Aldicarb	116063				1 CA						
Aldrin	309002	0.009 ^{mg} /L		1.5 (½)	0.017 V	0.65 (½)	0.15 CA				
Aldrin+Dieldrin+Endrin	na										
Allyl chloride	107051		0.1						13.4	3.32 V	0.06 D
Aminobiphenyl, 4-	92671		<0.03 W						3.05		5 D
Aminomethylphosphonic acid (AMPA)	1066519	0.797 L									
Amitrole	61825				22 NZ						
Aniline	62533				2.2 CA				56.8		
Anthracene	120127	0.0007	5	13 T	0.73 T	300 *C			1,48E6		
Aramid	140578				0.012 CA				16,600		
Atrazine	1912249	29 ^{mg} /L	3		1.8 CA		10 BC				0.2 D
Benz[a]anthracene	56553	0.0001		0.49 T	0.027 T	300 *C			5,210		
Benzene	71432	0.2	5	2,300 T	46 Eco	5,100 *	110 CA		255		10 D
Benzidine	92875			70 T	3.9 T						
Benz[ghi]perylene	191242	0.0003			7.64 V	300 *C			119,000		
Benzof[a]pyrene	50328	0.0005	0.2	0.24 T	0.014 T Eco	300 *C			1,520		

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 7. M - microbes; A - avian



Screening Quick Reference Tables for Organic in Water and Soil

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ANALYTE <small>All concentrations in parts per billion unless specified otherwise</small>	CAS Number	GROUND WATER		SURFACE WATERS				SOIL				
		Target	<u>Dutch</u> ¹ Intervention	<u>MCL</u> ²	Acute ³	Fresh Chronic ³	Marine Acute ³	Marine Chronic ³	Invertebrates ⁴	Mammals ⁵	Plants ⁶	Other ⁷
Benzofluoranthene	205992											
Benzofluoranthene	207089	0.0004	0.05			9.07 V	300 °C		59,800			
Benzoic acid	65850				740 T	42 T	300 °C		148,000			
Benzyl alcohol	100516				150 T	8.6 T			65,800			
BHC, alpha (α-HCH)	319846	33 ^{mg} /L	<1		39 T	2.2 T			99.4		3 D	
BHC, beta (β-HCH)	319857	8 ^{mg} /L	<1		39 T	2.2 T				3.98 V	9 D	
BHC, delta δ-HCH	319868	< 0.05	<1		39 T	0.495 V			9,940		< 10 D	
BHC, gamma- (γ-HCH; Lindane)	58899	9 ^{mg} /L	<1	0.2	0.95	0.08	0.08 (½)			5 V	0.05 D	
BHC (sum)	na	0.05	1		< 0.95	< 0.08	< 0.08				10 D	
Biphenyl	92524				14 T Eco					60,000		
Bis(2-chloroethoxy) methane	111911				11,000 °C		12,000 °C	6,400 °C	302			
Bis(2-chloroethyl) ether	111444					1,900 V			23,700			
Bis(2-ethylhexyl)phthalate (DEHP)	117817	1.9 ^{mg} /L	< 5	6	400 p	32 Eco 16 CA 0.3 V	400 p	360 p	925		< 100 D	
Bis-2-chloro-1-methylethylether	108601									19,900		
Bromocil	314409					5 CA				540		
Bromodichloromethane (Dichlorobromomethane)	75274			60 W	11,000 °C		12,000 °C	6,400 °C		15,900		
Bromoform (Tribromomethane)	75252		630		2,300 T	320 T Eco						
Bromoxnill	1689845			5 C		5 CA						
Butanol	35296721			5,600 S								
Butyl acetate, 1- or 2-	na		6,300 S									
Butyl benzyl phthalate	85687	2.9 ^{mg} /L	< 5		940 °C	19 T Eco	2,944 °C	3.4 °C	239		< 100 D	
Caplan	133062					1.3 CA						
Carbaryl	63252	2 ^{mg} /L	41 L	90 C		0.2 CA		0.32 CA				
Carbofuran	1563662	9 ^{mg} /L	6.5 L	40		1.8 CA		0.06 NZ				
Carbon disulfide	75150				17 T	0.92 T			94.1			
Carbon tetrachloride (Tetrachloromethane; Tetra)	56235	0.01	10	5	180 T	9.8 T	50,000 *	5,000 × 0.1	2,980		1,000,000 M 400 D	
Catechol (o-Dihydroxybenzene)	120809	0.2	630 L								50 D	

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		Target <small>Dutch¹</small>	Intervention	MCL ²	Acute ³ <small>Fresh</small>	Chronic ³ <small>Fresh</small>	Acute ³ <small>Marine</small>	Chronic ³ <small>Marine</small>	Invertebrates ⁴	Mammals ⁵	Plants ⁶	Other ⁷
Chlordane	57749	0.02 ^{mg} /L	0.2	2	1.2 (½)	0.00215 (½)	0.045 (½)	0.002 (½)			224 V	0.03 D
Chlordane (alpha)	5103719	< 0.02 ^{mg} /L	< 0.2								< 224 V	< 0.03 D
Chlordane (gamma)	5103742	< 0.02 ^{mg} /L	< 0.2								< 224 V	< 0.03 D
Chlorfenvinphos	470906					0.1 EU		0.1 EU	2,000			5 D
Chloroacetamide	79072											< 5 D
Chloroaniline	27134265		30						30,000		20,000	< 5 D
Chloroaniline, 3-	108429		< 30									< 5 D
Chloroaniline, 4-	106478		< 30		250 °C	50 °C	160 °C	129 °C		1,100		< 30 D
Chlorobenzenes (sum)	na	< 7	< 180	100		130 Eco < 47 V			< 40,000	< 13,100		30 D
Chlorobenzilate	510156									5,050		20 D
Chloroform (trichloromethane)	67663	6	400	200 W	490 T	1.8 CA				1,190		
Chloro, 4-2-methyl phenol	1570645		< 350 S							7,950		
Chloro, 4-3-methyl phenol	59507		< 350 S							< 7,950		
Chloro, 4- methyl phenols	na		350 S									
Chloro, 4-2-methylphenoxy acetic acid (MCPA)	94746	0.02	50	2 W		2.6 CA		4.2 CA				0.05 D
Chloronaphthalene, 1-	90131	3.7 ^{mg} /L	< 6							12.2		
Chloronaphthalene, 2-	91587	0.016 L	< 6		1,600 °C	0.396 V	7.5 °C			243		< 10 D
Chlorophenol, 2-	95578	< 0.3	< 100		4,380 *	490 NZ 24 V			10,000			< 10 D
Chlorophenol, 3-	108430	< 0.3	< 100								7,000	< 10 D
Chlorophenol, 4-	106489	< 0.3	< 100			220 NZ			< 10,000	< 243	< 7,000	< 10 D
Chlorophenols (sum)	na	0.3	100			< 24 V				2.9		< 10 D
Chloroprene	126998											
Chlorothalonil	1897456			200 BC		0.18 CA		0.36 CA				
Chlorpyrifos	2921882			30 W	0.083	0.041	0.011	0.0056				
Chrysene	218019	0.003	0.2				300 °C			4,730		< 50 D
Cresol [m-] (3-Methyl phenol)	108394	< 0.2	< 200							3,490		< 50 D
Cresol [o-] (2-Methyl phenol)	95487	< 0.2	< 200		230 T	13 T				40,400		< 50 D
Cresol [p-] (4-Methyl phenol)	106445	< 0.2	< 200							163,000		< 50 D
Cresols, sum	1319773	0.2	200		< 230 T	< 13 T				< 3,490		50 D
Cyclohexanone	108941	0.5	15,000									100 D

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		Target	Dutch ¹ Intervention	MCL ²	Fresh Acute ³	Chronic ³	Marine Acute ³	Chronic ³	Invertebrates ⁴	Mammals ⁵	Plants ⁶	Other ⁷
DDD, 4,4- (p,p-DDD, TDE)	72548	<0.004 ^{mg} /L	< 0.01	< 1 W	0.19 T	0.011 T	3.6 *	0.36 x 0.1		758		< 10 D
DDE, 4,4- (p,p-DDE)	72559	<0.004 ^{mg} /L	< 0.01	< 1 W	1.050 *	105 x 0.1	14 *	1.4 x 0.1		566		< 10 D
DDT, 4,4- (p,p-DDT)	50293	<0.004 ^{mg} /L	< 0.01	< 1 W	0.55 (½)	0.0005 (½)	0.065 (½)	0.0005 (½)		3.5		< 10 D
DDT+DDE+DDD (sum)	na	0.004 ^{mg} /L	0.01	1 W	<0.55 (½)	<0.0005 (½)	<0.065 (½)	<0.0005 (½)		21 EPA		93 A 10 D
Decane	124185				880 T	49 T						
Deltamethrin	52918635					0.0004 CA						
Demeton	8065483					0.1		0.1		452		
Diallate	2303164											
Diazinon	333415			20 C	0.17	0.17	0.82	0.82		18,400		
Dibenz[ah]anthracene	53703											
Dibenzofuran	132649				66 T	3.7 T	300 °C			35.2		
Dibromo, 1,2- 3-chloropropane (DBCP)	96128			0.2						2,050		
Dibromochloromethane (Chlorodibromomethane)	124481			100 W	11,000 °C		12,000 °C	6,400 °C		1,230		
Dibromoethane, 1,2-	106934			0.4 W								
Dicamba	1918009			120 C		10 CA						
Dichloro, 1,4- 2-butene (cis)	1476115											1,000,000 M
Dichloro, 1,4- 2-butene (trans)	110576											1,000,000 M
Dichloroaniline, 2,4-	554007		< 100 S			7 NZ			100,000			< 5 D
Dichloroaniline, 3,4-	95761		< 100 S			3 NZ	< 1,970 °S	150 NZ	20,000	2,960		< 5 D
Dichlorobenzene, 1,2-	95501	< 3	< 50	600	260 T	0.7 CA	< 1,970 °S	42 CA				< 30 D
Dichlorobenzene, 1,3-	541731	< 3	< 50		630 T	71 T Eco 38 V	< 1,970 °S		37,700			< 30 D
Dichlorobenzene, 1,4-	106467	< 3	< 50	75	180 T	15 T Eco 60 NZ 9.4 V	< 1,970 °S	129 °C	20,000	546		< 30 D
Dichlorobenzenes	25321226	3	50	< 75	< 180 T	< 0.7 CA 4.5 V	1,970 °S		< 20,000	< 548		< 30 D
Dichlorobenzidine, 3,3-	91941									646		
Dichlorodifluoromethane	75718									39,500		
Dichloroethane, 1,1-	75343	7	900		830 T	47 T Eco				20,100		20 D
Dichloroethane, 1,2-	107062	7	400	5	8,800 T	100 CA	113,000 *	11,300 x 0.1		21,200		20 D

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		Target	<u>Dutch</u> Intervention	MCL ²	Fresh		Marine		Invertebrates ⁴	Mammals ⁵	Plants ⁶	Other ⁷
					Acute ³	Chronic ³	Acute ³	Chronic ³				
Dichloroethene, 1,1- (vinylidene chloride)	75354	0.01	10	7	450 T	25 T	224,000 *S			8,280		100 D
Dichloroethene, 1,2- (cis or trans)	540590	0.01	20	70 cis 100	1,100 T 11,600 *S	590 T 1,160 x 0.1	224,000 *S 224,000 *S			784		200 D
Dichloroethene, 1,2- (trans)	156605											
Dichlorophenol, 2,4-	120832	< 0.2	< 30	900 C	2,020 *	160 NZ 11 V				87,500		< 10 D
Dichlorophenol, 2,6-	87650	< 0.2	< 30			< 0.2 CA				1,170		< 10 D
Dichlorophenol, 3,4-	95772	< 0.2	< 30			< 0.2 CA					20,000	< 10 D
Dichlorophenol, 3,5-	591355	< 0.2	< 30			< 0.2 CA						< 10 D
Dichlorophenols (sum)	na	0.2	30	< 900 C	< 2,020 *	0.2 CA			< 20,000	< 1,170	< 20,000	< 10 D
Dichloropropane, 1,2- (propylene dichloride)	78875	< 0.08	< 80	5	23,000 *S	5,700 *S	10,300 *S	3,040 *S	700,000	32,700		< 2 D
Dichloropropene, 1,3-	542756			20 W	0.99 T	0.055 T	790 *S					
Dichloropropene, 1,3- (cis)	10061015			< 20 W	< 0.99 T	< 0.055 T				398		
Dichloropropene, 1,3- (trans)	10061026			< 20 W	< 0.99 T	< 0.055 T				398		
Dichloropropene, 1,3- (trans)	51338273			9 C		6.1 CA		0.1 NZ				
Dicofol	115322					0.5 NZ						
Didecyl dimethyl ammonium chloride (DDAC)	7173515					1.5 CA						
Dieldrin ‡	60571	0.1 ⁹⁹ /L	< 0.1		0.24	0.056	0.355 (½)	0.00095 (½)		2.38		22 A
Diethyl phthalate	84662	< 0.5	< 5		1,800 T	210 T 110 V	2,944 *C	3.4 *C		24,800	100,000	< 100 D
Diethylene-glycol	111466		13,000 S									
Dihydroxybenzenes, sum	na	0.24 L										
Di-iso-butyl phthalate	84695	< 0.5	< 5									< 100 D
Dimethoate	60515			6 W		6.2 CA 0.15 NZ				218		
Dimethyl aminoazobenzene [p-]	60117									40		
Dimethyl benz(a)anthracene, 7,12-	57976									16,300		
Dimethyl benzidine, 3,3-	119937									104		
Dimethyl naphthalene, 2,6-	581420											
Dimethyl phenethylamine [alpha, alpha]	122098									300		
Dimethyl phenol, 2,4-	105679				2,120 *	100 V					10 V	
Dimethyl phthalate	131113	< 0.5	< 5		940 *C	3 *C	2,944 *C	3.4 *C	200,000	734,000		< 100 D

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ANALYTE <small>All concentrations in parts per billion unless specified otherwise</small>	CAS Number	GROUND WATER			SURFACE WATERS				SOIL			
		Target	Dutch ¹ Intervention	MCL ²	Fresh Acute ³	Chronic ³	Marine Acute ³	Chronic ³	Invertebrates ⁴	Mammals ⁵	Plants ⁶	Other ⁷
Di-n-butyl phthalate	84742	< 0.5	< 5		190 T	19 CA 9.7 V	2,944 °C	3.4 °C		150	200,000	< 100 D
Dinitrobenzene, 1,3-	99650									655		
Dinitrophenol, 2,4-	51285				230 °C	45 NZ 19 V	4,850 °C			60.9		
Dinitrotoluene, 2,4-	121142				330 *	65 NZ 44 V	590 * S	370 * S		1,280		
Dinitrotoluene, 2,6-	606202									32.8		
Di-n-octyl phthalate	117840	< 0.5	< 5		940 °C	3 °C	2,944 °C	3.4 °C		709,000		< 100 D
Dinoseb	88857			7		0.05 CA				21.8		
Dioxane, 1,4-	123911									2,050		
Dioxins (sum of PCDDs)	na		0.001 ^{mg} /L S							0.000199		
Diphenylhydrazine 1,2-	122667				270 *	27 x 0.1				1,010		
Diphenylamine	122394											
Diquat	85007			20		1.4 NZ				19.9		
Disulfoton	298044											
Diuron	330541			150 C		0.1EU		0.1EU				
Dodecylbenzene	25155300											
Endosulfan (α or β; I or II)	115297	0.2 ^{mg} /L	5		0.11 (½)	0.028 (½)	0.017 (½)	0.00435 (½)		119		0.01 D
Endosulfan sulfate	1031078					2.22 V				35.8		
Endrin	72208	0.04 ^{mg} /L	< 0.1	2	0.086	0.036	0.0185 (½)	0.00115 (½)		10.1		0.04 D
Endrin aldehyde	7421934					0.15 V				10.5		
Esfenvalerate	66230044					0.001 NZ						
Ethanol	64175					1,400 NZ						
Ethyl acetate	141786		15,000 S									
Ethyl benzene	100414	4	150	700	130 T	7.3 T 14 V	430 *	25 CA		5,160		30 D
Ethyl methacrylate	97632											
Ethylene glycol	107211		5,500 S			192,000 CA				30,000		
Famphur	52857									49.7		
Fenitrothion	122145					0.2 NZ						
Fluoranthene	206440					0.04 CA	40 *	11 Eco		122,000		
Fluorene	86737	0.003	1		3,980 *	3.9 T Eco	300 °C		30,000	122,000		

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		Target <small>Dutch¹</small>	Intervention	MCL ²	Acute ³	Fresh Chronic ³	Marine Acute ³ Chronic ³	Invertebrates ⁴	Mammals ⁵	Plants ⁶	Other ⁷
Formaldehyde	50000		50 S	900 W							
Furan	110009			280 C		65 CA				600,000	
Glyphosate	1071836			20 C		0.01 0.02 NZ		0.01			0.005 D
Guthion (azinphos-methyl)	865000	0.1 ^{mg} /L	2 S	0.4	0.26 (½)	0.0019 (½)	0.0265 (½)	0.0018 (½)		5.98	0.7 D
Heptachlor	76448	0.005 ^{mg} /L	0.3	0.2	0.26 (½)	0.0019 (½)	0.0265 (½)	0.0018 (½)		152	0.0002 D
Heptachlor epoxide	1024573	0.005 ^{mg} /L	3								
Hexachlorobenzene	118741	2.1E-7 L	0.5	1	6 P	3.68 P 0.0003 V	160 °C	129 °C		199	1,000,000 M
Hexachlorobutadiene (HCBD)	87683			0.6 W	90 *	1.3 CA 0.053 V	32 *	3.2 x 0.1		39.8	
Hexachlorocyclohexane (BHC)	608731				100 *	10 x 0.1	0.34 *	0.034 x 0.1		755	
Hexachlorocyclopentadiene	77474			50	7 *	5.2 *	7 *	0.7 x 0.1		10,000	
Hexachloroethane	67721				210 T	12 T Eco 8 V	940 *	94 x 0.1		566	
Hexachlorophene	70304									199	
Hexane	110543				10 T	0.58 T				12,600	
Hexanone, 2- (methyl butyl ketone)	591786				1,800 T	99 T					
Hydroquinone (p-dihydroxybenzene)	123319	0.2	800								50 D
Indeno[1,2,3-cd]pyrene	193395	0.0004	0.05			4.31 V	300 °C			109,000	
Iodo, 3-2-propyl butyl carbamate (IPBC)	55406536					1.9 CA					
Isodrin	465736									3.32 V	
Isophorone	78591				117,000 *	1,170 x 0.1 920 V	12,900 *	1,290 x 0.1		139,000	
Isoproturon	34123596			9 W		0.1 EU		0.1 EU		9,940	
Isosafrole	120581									32.7	
Kepone	143500										
Linear alkylbenzene sulfonates (LAS)	na					280 NZ					
Linuron	335502			190 C		7.0 CA		0.1			
Malathion	121755										
Maneb	12427382	0.05 ^{mg} /L	0.1								2 D
Methacrylonitrile	126987										
Methanol	67561		24,000 S							57	

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		<small>Dutch Target¹</small> Intervention	<small>MCL²</small>	<small>Fresh Acute³</small> Chronic ³	<small>Marine Acute³</small> Chronic ³	<small>Invertebrates⁴</small>	<small>Mammals⁵</small> Plants ⁶	<small>Other⁷</small>
Methanol	67561	24,000 S						
Methapyrene	91805						2,780	
Methomyl	16752775						19.9	
Methoxychlor	72435		40		3.5 NZ 0.03	0.03	235	
Methyl bromide	74839				16 V		10,400	
Methyl chloride	74873						77.9	
Methyl cholanthrene, 3-	56495						144	
Methyl, 2-4,6-dinitrophenol	534521						89,600	
Methyl ethyl ketone (MEK; 2-Butanone)	78933	6,000 S		240,000 T	14,000 T		1,230	
Methyl iodide	74884						984,000	
Methyl methacrylate	80626						315	
Methyl methanesulfonate	66273							
Methyl naphthalene, 1-	90120			37 T	2.1 T	300 °C	3,240	
Methyl naphthalene, 2-	91576				330 V		0.292	
Methyl parathion	298000						443,000	
Methyl, 4-2-pentanone	108101		9,200 S	2,200 T	170 T			
Methyl-tert-butyl ether (MTBE)	1634044				10,000 CA			
Methylene bromide (Dibromomethane)	74953			11,000 °C		12,000 °C	5,000 CA	
Methylene chloride (Dichloromethane, DCM)	75092	0.01	1,000	5 26,000 T	2,200 T 98.1 CA	6,400 °C	6,400 °C	4,050
Metolachlor	51218452							
Metribuzin	21087649			10 W 80 C	7.8 CA 1 CA			
Mineral oil (Operationally defined)	8012951	50	600					
Mirex	2385855				0.001	0.001		
Molinate	2212671			6 W	3.4 NZ			
Monochloroaniline (3 isomers)	na		30					5 D
Monochlorobenzenes	108907	7	180	100	1.3 CA	160 °C	25 CA	< 30 D
Monochloronaphthalenes	7.7 ^{mg} /L	6						120 L
Monochlorophenols (sum)	na	0.3	100		7 CA			< 10 D
Naphthalene	91203	0.01	70		1.1 CA	2,350 *	1.4 CA	
Naphthoquinone, 1,4-	130154							

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		<small>Dutch¹ Target</small>	<small>Intervention</small>	<small>MCL²</small>	<small>Fresh Acute³</small>	<small>Marine Acute³</small>		<small>Chronic³</small>	<small>Mammals⁵</small>	<small>Plants⁶</small>
Naphtthylamine, 1-	134327									
Naphtthylamine, 2-	91598							9,340		
Nitroaniline [m-]	99092							3,030		
Nitroaniline [p-]	100016							3,160		
Nitroaniline, 2-	88744							21,900		
Nitrobenzene	98953							74,100		
Nitro-o-toluidine, 5-	98958							1,310		1,000,000 M
Nitrophenol, 2-	88755							8,730		
Nitrophenol, 4-	100027							1,600		
Nitroquinoline, 4-1-oxide	56575							5,120		
Nitrosodimethylamine, N-	55185							122		
Nitrosodimethylamine, N-	62759							69.3		
Nitroso-di-n-butylamine, N-	924163							0.0321		
Nitroso-di-n-propylamine, N-	621647							267		
Nitrosodiphenylamine, N-	86306							544		
Nitrosomethylethylamine, N-	10595956							545		
Nitrosomorpholine, N-	59892							1.66		
Nitrosopiperidine, N-	100754							70.6		
Nitrosopyrrolidine, N-	930552							6.65		
Nonylphenol	25154523							12.6		
O,O-diethyl O-2-pyrazinylphosphorothioate	297972									
Octanone, 2-	111137							799,000		
PAHs, High MW	na							29,000 EPA		< 1,000 D
PAHs, Low MW	na							18,000 EPA		< 1,000 D
PAHs, Total	na							100,000 EPA		1,000 D
Paraquat	4685147							0.34 V		
Parathion	56382							0.332		
PCBs (sum)	1336363							40,000		< 20 D
Pentachloroaniline	527208									

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		Dutch ¹ Target	Intervention	MCL ²	Fresh ³ Acute	Chronic ³	Marine ³ Acute	Chronic ³	Invertebrates ⁴	Mammals ⁵	Plants ⁶	Other ⁷
Pentachlorobenzene	608935	0.003	1		8.4 T	0.47 T 0.019 V	160 °C	129 °C	20,000	497		< 30 D
Pentachloroethane	76017				7,240 *	1,100 *	390 *	281 *		10,700		
Pentachloronitrobenzene	82688									7,090		
Pentachlorophenol [PCP: at pH 7.8]	87865	0.04	3	1.0	19 Ph 2,000 T	15 Ph 110 T	13	7.9	6,000	119	3,000	2,100 A
Pentanol, 1-	71410											
Permethrin	52645531					0.004 CA		0.001 CA				
Phenacetin	62442									11,700		
Phenanthrene	85018	0.003	5		30 P	6.3 P Eco 3.6 V	7.7 P	4.6 P		45,700		
Phenol	108952	0.2	2,000		10,200 *	320 NZ 180 V	5,800 *	400 NZ	30,000	120,000	70,000	1,000,000 M 500 D
Phenylenediamine [p-]	106503									6,160		
Phorate	298022			2 C						0.496		
Phthalates (sum)	na	0.5	5	500								100 D
Picloram	1918021					29 CA						
Picoline, 2-	109068									9,900		
Polychlorinated dibenzofurans	51207319									0.0386		
Pronamide	23950585										13.6 V	
Propanol, 2- (isopropanol)	67630		31,000 S		130 T	7.5 T						
Propionitrile	107120									49.8		
Propylene glycol	57556					500,000 CA				78,500		
Pyrene	129000					0.025 CA	300 °C			1,030		
Pyridine	110861	0.5	30									100 D
Quinoline	91225					3.4 CA						
Resorcinol (m-dihydroxybenzene)	108463	0.2	600									50 D
Safrole	94597											
Silvex (2,4,5-TP)	93721			50						404		
Simazine	122349			4				1 EU			109 V	
Styrene (Vinyl benzene)	100425	6	300	100		10 CA 3.2 NZ 72 CA 32 V				4,690	300,000	300 D

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		Target ¹	Intervention	MCL ²	Fresh Acute ³	Chronic ³	Marine Acute ³		Chronic ³	Invertebrates ⁴	Mammals ⁵	Plants ⁶
Tebuthiuron	34014181			490 BC		1.6 CA 2.2 NZ 0.05 NZ		0.05 NZ				
Temephos	3383968		< 10 S						20,000		20,000	
Tetrachloroaniline, 2,3,5,6-	3481207	< 0.01	< 2.5		250 °C	1.8 CA	160 °C	129 °C	10,000			< 30 D
Tetrachlorobenzene, 1,2,3,4-	634662	< 0.01	< 2.5		250 °C		160 °C	129 °C				< 30 D
Tetrachlorobenzene, 1,2,3,5-	634902	< 0.01	< 2.5		250 °C	50 °C 3 V	160 °C	129 °C		2,020		< 30 D
Tetrachlorobenzene, 1,2,4,5-	95943	< 0.01	< 2.5		250 °C	< 3 V	160 °C	129 °C	< 10,000	< 2,020 225,000		< 30 D
Tetrachlorobenzenes	na	0.01	2.5									
Tetrachloroethane, 1,1,1,2-	630206				2,100 T					127		
Tetrachloroethane, 1,1,2,2-	79345				830 T					9,920		2 D
Tetrachloroethylene (Tetrachloroethene; PCE; PER)	127184	0.01	40	5		111 CA 98 T 45 V	9,020 *	902 × 0.1 450 *				< 10 D
Tetrachlorophenol, 2,3,4,5-	4901513	< 0.01	< 10			< 1 CA			20,000			< 10 D
Tetrachlorophenol, 2,3,4,6-	58902	< 0.01	< 10	100 C		20 NZ	440 *	44 × 0.1	< 20,000	< 199		< 10 D
Tetrachlorophenols (sum)	25167833	0.01	10			1 CA				596		
Tetraethylthiopyrophosphate	3689245											
Tetrahydrofuran	109999	0.5	300									100 D
Tetrahydrothiophene	110010	0.5	5,000									100 D
Thiobencarb	28249776											
Thiram	137268					2.8 NZ 0.2 NZ						
Toluene	108883	7	1,000	1,000	120 T	9.8 T 2 CA	6,300 *	0.01 NZ 215 CA		5,450 2,970	200,000	10 D
Toluidine [o-]	95534											
Toxaphene	8001352			3	0.73	0.0002	0.21	0.0002				
Triallate	2303175					0.24 CA						
Tributyltinoxide	56359	< 0.05E-16 mg/L	< 0.7		0.46	0.072	0.42	0.0074				< 1 D
Trichloroaniline (multiple isomers)	na		10 S									
Trichloroaniline, 2,4,5-	636306		< 10 S						20,000		20,000	
Trichlorobenzene, 1,2,3-	87616	< 0.10	< 10			8.0 CA	160 °C		20,000			< 30 D
Trichlorobenzene, 1,2,4-	120821	< 0.10	< 10	70	700 T	24 CA	160 °C	5.4 CA	20,000	11,100		< 30 D
Trichlorobenzenes	12002481	0.01	10	< 70	< 700 T	< 8 CA	160 °C	< 5.4 CA	< 20,000	< 11,100		< 30 D

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		<small>Dutch¹</small> Target	<small>MCL²</small> Intervention	<small>Fresh</small> Acute ³	<small>Chronic³</small>	<small>Marine</small> Acute ³	<small>Chronic³</small>	<small>Invertebrates⁴</small>	<small>Mammals⁵</small>	<small>Plants⁶</small>	<small>Other⁷</small>
Trichloroethane, 1,1,1-	71556	0.01	300	200 T	11 T	31,200 *	3,120 x 0.1		29,800		70 D
Trichloroethane, 1,1,2-	79005	0.01	130	5	1,200 T 500 V		1,900 NZ		28,600		400 D
Trichloroethene (TCE)		24	500	5	21 CA	2,000 *	200 x 0.1		12,400		100 D
Trichloroethene, 1,1,1-	71556	< 24	< 500	< 5	< 440 T	< 21 CA					< 100 D
Trichloroethene, 1,1,2-	79016	< 24	< 500	< 5	< 440 T	< 21 CA					< 100 D
Trichlorofluoromethane	75694				11,000 *C	12,000 *C	6,400 *C		16,400		
Trichlorophenol, 2,3,5-	95954	< 0.03	< 10		< 18 CA						< 10 D
Trichlorophenol, 2,4,5-	88062	< 0.03	< 10	5 C	63 p	240 p	11 p	9,000	14,100	4,000	< 10 D
Trichlorophenol, 2,4,6-	na	0.03	10		20 NZ 4.9 V 18 CA			10,000	9,940		< 10 D
Trichlorophenols, (sum)	96184							< 9,000	< 9,940		
Trichloropropane, 1,2,3-	126681								3,360		
Triethylphosphorothioate [O,O,O-]	1582098			20 W			0.1EU		818		
Trifluralin	99354				0.2 CA				376		
Trinitrobenzene, 1,3,5-	118967				140 NZ						
Trinitrotoluene, 2,4,6-	108054				16 T				12,700		
Vinyl acetate	75014	0.01	5	2	930 V				646		10 D
Vinyl chloride	108383	< 0.2	< 70		1.8 T Eco						< 100
Xylene, m-	95476	< 0.2	< 70		350 NZ						< 100
Xylene, o-		< 0.2	< 70								< 100
Xylene, p-		0.2	70	10,000	13 T						100 D
Xylenes	1330207									10,000 v	

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Sources

- 1 – Entry is lower of current VROM Environmental Quality standards or the updated RIVM Environmental Risk Limits. Risk limits are typically divided by 100 to derive the Target value; this computation has been done here.
Dutch Target/Intervention: E.M.J. Verbruggen, R. Posthumus and A.P. van Wezel, 2001. Ecotoxicological Serious Risk Concentrations for soil, sediment, and (ground)water: updated proposal for first series of compounds. Nat. Inst. Public Health and the Env., and subsequent updates as published elsewhere.
Min. Housing, Spatial Plan. And the Env., 2000. Annexes Circular on target values and intervention values for soil remediations.
- 2 – Primary entry is the US EPA MCL value, followed by the lower of appropriate WHO, Canadian, or British Columbia guidelines.
Maximum Contaminant Levels (MCLs): <http://www.epa.gov/safewater/index.html>
W – World Health Organization's (WHO) Drinking water guidelines: http://www.who.int/water_sanitation_health/dwg/en/
C – Canadian Environmental Quality Guidelines for Community Water, Summary Table Update 2002: <http://www.ccme.ca>
BC – British Columbia Water Quality Guidelines (either working or recommended): <http://www.env.gov.bc.ca/wat/wq/>
- 3 – Primary entry is the US Ambient Water Quality Criteria, followed by the lowest of Tier II SA's or available standards or guidelines.
Lowest Observable Effect Levels (LOELs) previously published by EPA are also included since these essentially were the basis for many state standards.
EPA Ambient water Quality Criteria (AWQC): <http://www.epa.gov/waterscience/criteria/aq/criteria.html>
T – Tier II Secondary Acute Value: <http://www.esd.ornl.gov/programs/ecorisk/tools.html>
Eco – EPA Ecoupdate, Ecotox Thresholds: EPA 540/F-95/038
CA – Canadian water Quality Guidelines: <http://www.ec.gc.ca/CEQG-RCQE/English/Ceqq/Water/default.cfm>
BC – British Columbia Water Quality Guidelines (either working or recommended): <http://www.env.gov.bc.ca/wat/wq/>
EU – European Union (EU) Environmental Quality Standards: COM(2006) 397 and 398 final.
V – US EPA Region V Ecological Screening Levels: <http://www.epa.gov/reg5/cra/calcedq.htm>
- 4 – Toxicological Benchmarks for Effects on Earthworms: <http://www.esd.ornl.gov/programs/ecorisk/tools.html>
EPA – Eco-SSL for Invertebrates: <http://www.epa.gov/ecotox/ecossil/>
Region V Ecological Screening Level for Invertebrates: <http://www.epa.gov/reg5/cra/cal/>
- 5 – Entry is lower of either:
Region V Ecological Screening Level for shrew or vole: <http://www.epa.gov/reg5/cra/cal/>
EPA – Eco-SSL for Mammals: <http://www.epa.gov/ecotox/ecossil/>
- 6 – Toxicological Benchmarks for Effects on Terrestrial Plants: <http://www.esd.ornl.gov/programs/ecorisk/tools.html>
V – EPA Region V Ecological Screening Level for Plants: <http://www.epa.gov/reg5/cra/cal/>
- 7 – Entry is lower of either:
M – Toxicological Benchmarks for Effects on Microbes: <http://www.esd.ornl.gov/programs/ecorisk/tools.html>
A – Eco-SSL for Avian Receptors: <http://www.epa.gov/ecotox/ecossil/>
D – Entry is lower of current VROM Environmental Quality standards or the updated RIVM Environmental Risk Limits. See #1 above for sources.



Screening Quick Reference Table for PCB Composition

These tables were developed for screening purposes only: they do not represent official NOAA policy and do not constitute criteria or clean-up levels. All attempts have been made to ensure accuracy; however, NOAA is not liable for errors. Values are subject to changes as new data become available.

Degree of Chlorination	A1221 Wt %	A1232 Wt %	A1016 Wt %	A1242 Wt %	A1248 Wt %	A1254 Wt %	A1260 Wt %	A1262 Wt %
Biphenyl	11.7 a	6.2 a						
Σ1 Cl	65.5	31.3	Tr (#1, 3)	Tr (#1, 3)				
Σ2 Cl	30.0	26.1	15.2	11.5	Tr (#7, 8)			
Σ3 Cl	3.5	21.7	58.2	51.0	21.8	2.1		
Σ4 Cl	Tr	15.0	26.5	29.0	60.2	14.3	Tr (#52, 70, 74)	Tr (#52, 70, 74)
Σ5 Cl	Tr (#95)	5.8	Tr (#91, 95, 102)	8.5	17.1	53.2	8.2	3.5
Σ6 Cl				Tr (#136, 138)	0.8	26.6	47.2	31.6
Σ7 Cl					Tr	3.8	37.6	45.8
Σ8 Cl						Tr (#202)	6.3	17.7
Σ9 Cl							0.7	1.3
Total	99.1%	99.94%	99.95%	100%	99.93%	99.95%	100.01%	99.98%
Prominent congeners b	1 3 8 4 15 6	1 8 3 4 15 28	18 28 8 31 33 16	18 28 31 8 33 16	66 70 64 28 52 60	118 110 101 95 136 153	180 138 149 187 174 170	180 153 187 149 174 203
Unique congener	#11 Tr					#137	#189 Tr	
Peak Range c	1-48	1-74	2-50	2-82	8-106	8-107	31.1-117	31.1-117
Ratio #118:203 d	Neither	No #203	Neither	No #203	73	370 - 1230	0.3 - 0.5	0.1
Ratio #31:118 e	No #118	4.3	No #118	8.5 - 9.2	2.1	0.01 - 0.04	0.1	No #31
Wt % of #153 f				0.1 - 0.14	Tr - 0.52	4.7-6.1		
Additional Information		~ 1:1 mix of 1221-1242	Distillation of 1242					

Notes

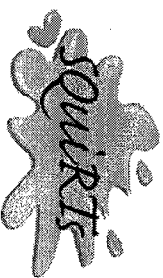
Commercial PCBs were manufactured by chlorination of biphenyl to produce complex mixtures (Aroclors in the USA and Great Britain, Clophens in Germany, or Kanechlor in Japan), each containing 60 to 90 different molecular species (*congeners*) and a specified weight percent of chlorine (for example, 54% in Aroclor 1254). There are 209 distinct congener structures possible, of which about 140 to 150 have been detected at significant levels in commercial PCBs.

Congener distributions in environmental samples roughly resemble those of the parent commercial mixtures, but are often modified due to evaporation, water extraction, microbial oxidation or dechlorination, photochemical dechlorination or differential biological uptake and metabolism. Compositional modification from original Aroclor patterns increases in biotic samples with trophic level. Still, it is often useful or necessary to attempt distinguishing the parent mixture released. The following information is presented to provide assistance with initial, preliminary evaluation of Aroclor. *Aroclor assignment should be conducted only by qualified chemists.*

Total PCBs can be characterized by two primary methods – the sum of congeners, or, the sum of estimates of individual Aroclor concentrations. In lower trophic level samples, these two methods provide approximately equal estimates of total PCBs. At higher trophic levels, analyses of samples tend to overestimate total PCBs by as much as 2-fold using the sum of Aroclor method, due to an overestimation of Aroclor 1254.

Tr - Individual congeners are at trace levels - 0.05 to 0.5% each - and are not included in totals.	e - This ratio is often used as an indicator for Aroclor 1248.
# - Refers to IUPAC congener number; IUPAC #s: 107, 108, 109, 199, 200, 201 correspond to BZ#s 108, 109, 107, 201, 199, and 200, respectively.	f - Congener 153 is persistent in biota and abundantly present in higher chlorinated Aroclors and so provides a degree of modification estimate for biotic samples (increasing modification with decreasing PD values):
a - Biphenyl figures are not reflected in congener weight percentages.	
b - The six most prominent peaks listed by IUPAC congener number.	
c - In the 118 peak numbering system, peak 1 is biphenyl.	
d - This ratio is often used as an indicator for Aroclor 1260.	

$$PD_{153} = \left[\frac{\#153_{Aroclor} - \#153_{sample}}{\#153_{sample}} \right] * 100$$



Screening Quick Reference Table for Toxic Equivalency Factors

These tables were developed for screening purposes only; they do not represent official NOAA policy and do not constitute criteria or clean-up levels. All attempts have been made to ensure accuracy; however, NOAA is not liable for errors. Values are subject to changes as new data become available.

Compound	2005 Mammals / human TEF	1998 Fish TEF	1998 Avian TEF
CHLORINATED DIBENZO-P-DIOXINS			
2,3,7,8-TCDD	1	1	1
1,2,3,7,8-PeCDD	1	1	1
1,2,3,4,7,8-HxCDD	0.1	0.5	0.05
1,2,3,6,7,8-HxCDD	0.1	0.01	0.01
1,2,3,7,8,9-HxCDD	0.1	0.01	0.1
1,2,3,4,6,7,8-HpCDD	0.01	0.001	<0.001
OCDD	0.0003	<0.0001	<0.0001
CHLORINATED DIBENZOFURANS			
2,3,7,8-TCDF	0.1	0.05	1
1,2,3,7,8-PeCDF	0.03	0.05	0.1
2,3,4,7,8-PeCDF	0.3	0.5	1
1,2,3,4,7,8-HxCDF	0.1	0.1	0.1
1,2,3,6,7,8-HxCDF	0.1	0.1	0.1
1,2,3,7,8,9-HxCDF	0.1	0.1	0.1
2,3,4,6,7,8-HxCDF	0.1	0.1	0.1
1,2,3,4,6,7,8-HpCDF	0.01	0.01	0.01
OCDF	0.0003	<0.0001	0.0001
NON-ORTHO-SUBSTITUTED PCBs			
3,3#,4,4#-tetrCB (PCB 77)	0.0001	0.0001	0.05
3,4,4#,5-tetrCB (PCB 81)	0.0003	0.0005	0.1
3,3#,4,4#,5-pentaCB (PCB 126)	0.1	0.005	0.1
3,3#,4,4#,5,5#-hexaCB (PCB 169)	0.03	0.00005	0.001
MONO-ORTHO-SUBSTITUTED PCBs			
2,3,3#, 4,4#-pentaCB (PCB 105)	0.00003	<0.000005	0.0001
2,3,4,4#,5-pentaCB (PCB 114)	0.00003	<0.000005	0.0001
2,3,4,4#,5-pentaCB (PCB 118)	0.00003	<0.000005	0.00001
2#, 3,4,4#, 5-pentaCB (PCB 123)	0.00003	<0.000005	0.00001
2,3,3#, 4,4#,5-hexaCB (PCB 156)	0.00003	<0.000005	0.0001
2,3,3#, 4,4#,5#-hexaCB (PCB 157)	0.00003	<0.000005	0.0001
2,3,4,4#,5,5#-hexaCB (PCB 167)	0.00003	<0.000005	0.00001
2,3,3#, 4,4#, 5,5#-heptaCB (PCB 189)	0.00003	<0.000005	0.00001

It has been well established that 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), and other chlorinated dioxins, furans, and even PCBs with a similar planar chemical structures are capable of inducing similar toxicity, such as carcinogenicity. Since these compounds generally are observed in mixtures, it is desirable to be able to express the cumulative, overall toxicity of the mixture. However, since each of these congeners does not exhibit the same degree, or potency, of toxicity, some manipulations of raw concentrations are required to express total toxicity.

A number of systems have been developed to express the total, overall toxicity from mixtures of these chemicals. Most commonly, the potency of each congener is weighted relative to a standard, generally the most potent congener. For dioxins and furans, 2,3,7,8-TCDD is the common standard which is given a reference value of one. The weighting, or potency factor, is called a Toxic Equivalency Factor (TEF). When cumulative results are reported, the absolute concentration of each congener is multiplied by its corresponding TEF to derive a TCDD-equivalency. These values are then summed together to give a total Toxic Equivalency Quotient, or TEQ.

The TEQ scheme refers *only* to adverse effects (e.g., cancer) following interactions with certain cellular enzyme systems (the Ah receptors). Other toxic effects of dioxins and dioxin-like compounds are not quantified by this method. Because they involve potency to specific enzyme systems, TEF values vary for different animal species.

There are two main schemes:

The two most common systems for determining TEQs are:

- 1) **I-TEF and I-TEQ:** The older International Toxic Equivalent (I-TEQ) scheme by the North Atlantic Treaty Organization (NATO) initially set up in 1989 and later extended and updated.

- 2) **WHO-TEF and WHO-TEQ** (also referred to as TEF or TEQ): More recently, the World Health Organization (WHO) suggested modified Toxic Equivalency Factor (TEF) values for human risk assessment.

ITEQs are most common in North America, while Asia and Europe tend to use WHO-TEQs. On average, the result of TEQ-calculations is about 10% higher when I-TEFs are used compared to when WHO-TEFs are used.

Potency in fish reflects mainly rainbow trout; potency for birds is mainly derived from chickens.

Sources

Van den Berg, M., and others. 1998. "Toxic Equivalency Factors (TEFs) for PCBs, PCDDs, and PCDFs for Humans and Wildlife." *Environmental Health Perspectives*. Volume 106, Pages 775 - 792.

Van den Berg, M., and others. 2006. "The 2005 World Health Organization Re-evaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-like Compounds." *Toxicological Sciences* 93(2):223-241.



Screening Quick Reference Tables for Composition by Carbon Range

These tables were developed for screening purposes only; they do not represent official NOAA policy and do not constitute criteria or clean-up levels. All attempts have been made to ensure accuracy; however, NOAA is not liable for errors. Values are subject to changes as new data become available.

GAS		VAPOR		LIQUID		OIL		THICK OIL		SEMI-SOLID		SOLID	
Carbon Number													
Analytes													
BTX													
Number 2 Diesel Range													
JP-5, 7, 8													
Gasoline													
Standard Solvent													
Chlorinated Solvents													
JP-4													
Fuel Oil													
Lubricating Oils													
Creosote/Greases/Waxes/Pitch/Asphalt													
U.S. EPA 418.1: TPH in water													
U.S. EPA 8015 (modified)													
U.S. EPA 8015 (modified) by extraction: nonhalogenated organics													
U.S. EPA method 8015 (modified)													
U.S. EPA 8260B: VOCs													
U.S. EPA 8270C: SVOCs													
U.S. EPA 8021B: Aromatic & Halogenated volatiles													
Analytic Methods													

Carbon ranges are approximate; actual carbon ranges for a specific product are dependent upon the distillation process of the exact source.

Analytic Methods generally refer to EPA SW-846 methods (www.epa.gov/SW-846/index.htm)



Screening Quick Reference Tables for Sample Collection and Storage

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MATERIAL	CONTAINER	PRESERVATION	MAXIMUM HOLDING TIME	SAMPLE SIZE
INORGANICS				
Chromium ⁺⁶ (Cr ⁺⁶)	P, G	Cool, 4°C	24 hours	400 mL/200 g
Mercury (Hg)	P, G	HNO ₃ to pH <2	28 days	400 mL/200 g
Metals, except Cr ⁺⁶ and Hg	P, G	HNO ₃ to pH <2	6 months	600 mL/200 g
Cyanide by method no. 9010	P, G	Cool 4°C, pH >12 See method 9010	14 days	1,000 mL
Alpha, Beta, and Radium Radiation	P, G	HNO ₃ to pH <2	6 months	1,000 mL
ORGANICS				
Benzidines	G, TLC	Cool, 4°C	7 days until extraction, 40 days after extraction	1,000 mL
Chlorinated Hydrocarbons	G, TLC	Cool, 4°C	7 days until extraction, 40 days after extraction	1,000 mL
Dioxins and Furans	G, TLC	Cool, 4°C	30 days until extraction, 45 days after extraction	1,000 mL
Halobethers	G, TLC	Cool, 4°C	7 days until extraction, 40 days after extraction	1,000 mL
Nitrites	G, TLC	Cool, 4°C	14 days	
Nitrosamines	G, TLC	Cool, 4°C	7 days until extraction, 40 days after extraction	1,000 mL
Nitroaromatics and Cyclic Ketones	G, TLC	Cool, 4°C	7 days until extraction, 40 days after extraction	1,000 mL
OIL And GREASE	G	Cool, 4°C	28 days	1,000 mL
TOTAL Organic Carbon, By Method No. 9060	P, G	Cool, 4°C store in the dark	28 days	100 mL
TOTAL Organic Halides By Method No. 9020/9021	G, TLC	Cool, 4°C	28 days	500 mL
PCBs	G, TLC	Cool, 4°C	7 days until extraction, 40 days after extraction	1,000 mL/250 mL
Pesticides	G, TLC	Cool, 4°C	7 days until extraction, 40 days after extraction	1,000 mL/250 mL
Phenols	G, TLC	Cool, 4°C	7 days until extraction, 40 days after extraction	1,000 mL
Phthalate Esters	G, TLC	Cool, 4°C	7 days until extraction, 40 days after extraction	1,000 mL
Polynuclear Aromatic Hydrocarbons	G, TLC	Cool, 4°C store in the dark	7 days until extraction, 40 days after extraction	1,000 mL/250 mL
Purgeable Aromatic Hydrocarbons	VOA	Cool, 4°C	14 days	40 mL
Purgeable Halocarbons	VOA	Cool, 4°C	14 days	40 mL

Sources

EPA SW846

1. P - Polyethylene, G - Amber glass containers, TLC - Teflon-lined cap, VOA - Volatile organic analyte vial of amber glass with teflon-lined septum.
2. Adjust to pH <2 with H₂SO₄, HCl, or solid NaHSO₄
3. Free chlorine must be removed before addition of HCl by exact addition of Na₂S₂O₃



Screening Quick Reference Table Options for Selection of Analytical Methods: Inorganics

These tables were developed for screening purposes only; they do not represent official NOAA policy and do not constitute criteria or clean-up levels. All attempts have been made to ensure accuracy; however, NOAA is not liable for errors. Values are subject to changes as new data become available.

TRACE ELEMENT	OTHER ¹	FLAME AA	FURNANCE AA	ICP	EXTRACTION METHODS	
					WATER	SOIL/SEDIMENT
Aluminum (Al)	6800	7020	7041 7062 ³	6010B 6020A	3005A 3010A 3015A	3050B 3051A
Antimony (Sb)	6200(5) 6800	7040	7060 7062 ³	6010B 6020A	3005A 3010A 3015A	3050B 3051A
Arsenic (As)	6200(60) 7063 7061A ³			6010B 6020A	3005A 3010A 3015A 7063	3050B 3051A
Barium (Ba)	6200(60) 6800	7080A	7081 ³	6010B 6020A	3005A 3010A 3015A	3050B 3051A
Beryllium (Be)		7090	7091	6010B 6020A	3005A 3010A 3015A 3020A	3050B 3051A
Cadmium (Cd)	6200 6800	7130	7131A	6010B 6020A	3005A 3010A 3015A 3020A	3050B 3051A
Calcium (Ca)	6200 6800	7140		6010B 6020A	3005A 3010A 3015A	3050B 3051A
Chromium (Cr), total	6200(200) 6800	7190	7191	6010B 6020A	3005A 3010A 3015A 3020A	3050B 3051A
Chromium+6 (Cr+6)	7195 — 7199 ³				7195 - 7199	3060A
Cobalt (Co)	6200(330)	7200	7201	6010B 6020A	3005A 3010A 3015A 3020A	3050B 3051A
Copper (Cu)	6200(85) 6800	7210	7211 ³	6010B 6020A	3005A 3010A 3015A	3050B 3051A
Iron (Fe)	6200 6 800	7380	7381 ³	6010B 6020A	3005A 3010A 3015A	3050B 3051A
Lead (Pb)	6200(45) 6800	7420	7421	6010B 6020A	3005A 3010A 3015A 3020A	3051A
Magnesium (Mg)	6800	7450		6010B 6020A	3005A 3010A 3015A	3050B 3051A
Manganese (Mn)	6200(240)	7460	7461	6010B 6020A	3005A 3010A 3015A	3050B 3051A
Mercury (Hg)	4500(0.5) 6200 6800 7470A 7471B 7472 7473 7474 ³			6020A	7470A 7472 3015A	3051A 7471B 7473 7474
Molybdenum (Mo)	6200(25) 6800	7480	7481	6010B	3005A 3010A 3015A 3020A	3050B 3051A
Nickel (Ni)	6200(100) 6800	7520	7521	6010B 6020A	3005A 3010A 3015A	3050B 3051A
Potassium (K)	6200 6800	7610		6010B 6020A	3005A 3010A 3015A	3050B 3051A
Selenium (Se)	6200 6800 7741A 7742 ³		7740	6010B 6020A	3005A 3010A 3015A	3050B 3051A
Silver (Ag)	6200 6800	7760A	7761 ³	6010B 6020A	3005A 3015A	3051A 7760 7761
Sodium (Na)		7770		6010B 6020A	3005A 3010A 3015A	3050B 3051A
Strontium (Sr)	6200(30) 6800	7780		6010B	3015A	3050B 3051A
Thallium (Tl)	6200 6800	7840	7841	6010B 6020A	3005A 3010A 3015A 3020A	3050B 3051A
Tin (Sn)	6200(85)	7870				3050B 3051A
Vanadium (V)	6200 6800	7910	7911	6010B 6020A	3005A 3010A 3015A 3020A	3050B 3051A
Zinc (Zn)	6200(80) 6800	7950	7951 ³	6010B 6020A	3005A 3010A 3015A	3050B 3051A
Cyanide (HCN)	9010B — 9014 ³					

Sources

All method numbers refer to EPA SW-846, Volume III with changes as proposed for Volume IV. ICP's advantage is that it allows simultaneous or rapid sequential determination of many elements, but suffers from interferences. AA determinations are normally completed as single element analyses. ICP and Flame AA have comparable detection limits (within a factor of 4), but ICP-MS (6020A) can drastically improve the detection limits (e.g., an order of magnitude lower). Furnace AA generally exhibits lower detection limits than ICP or Flame-AA, and offers more control over unwanted matrix components. X-RAY and immunoassays allow field determinations.

1. Method 6200 is Portable X-Ray; 6800 is Elemental/Scope Mass Spec; 4500 is immunoassay; 7063 is ASV, where available; soil detection limits in ppm are in parentheses.
2. Except as noted, most individual procedures are proposed to be integrated into Method 7000B or 7010.
3. Includes various methods. Follow the extraction procedure detailed in the individual determinative method.



Screening Quick Reference Table

Options for Selection of Analytical Methods: Organics

These tables were developed for screening purposes only; they do not represent official NOAA policy and do not constitute criteria or clean-up levels. All attempts have been made to ensure accuracy; however, NOAA is not liable for errors. Values are subject to changes as new data become available.

C O M P O U N D S	F I E L D M E T H O D S	O C / M S M E T H O D	S P E C I F I C D E T E C T I O N M E T H O D	H P L C M E T H O D	E X T R A C T I O N M E T H O D S		C L E A N U P M E T H O D
					W A T E R	S O I L / S E D I M E N T	
Aromatic and Halogenated Volatiles		8260B	8021B	8318 8321B	5021 5030B 5032 8318 8321B	5021 5032 5035 8318 8321B	8318
Carbamates			8280B 8290A			8280B 8290A 3545A	8280B 8290A
Chlorinated Dioxins and Furans		8270D	8121		3510C 3520C 3535A	3540C 3550B	3620B 3640A
Chlorinated Hydrocarbons		8270D 2	8151A	8321B	8151A 8321B 3535A	8321B 8151A 3545A 3560A	8151A 3620B
Chlorinated Phenoxycarbons	4015 (0.1 ppm)	8270D	8111		3510C 3520C	3540C 3545 3550B	3620B 3640A
Haloethers		8260B	8031 8032A 8033	8315 8316	5030B — 5032 8031 8032A 8316	5031 5032 5035	8032A
Nitriles and Amides		8270D	8091	8330A	3510C 3520C 3535A	3540C 3545 3550B	3620B 3640A
Nitroaromatics and Ketones							
Nitroaromatics (Explosives)	4050 (0.5 ppm) 4051 8515 (1 ppm)			8330A - 8332	8330A — 8332	8330A — 8332	8330A — 8332 3620B
Nitrosamines		8270D	8070A		3510C 3520C 8070A	3540C 3545 3550B 8070A	3610B 3620B 3640A 8070A
Non-Halogenated Volatiles		8260B	8015B		5030B — 5032	5021 5031 5032 5035	
Organochlorines	4040 — 4042 (0.2 to 20 ppm)	8270D 2	8081B 8275A		3510C 3520C 3535A	3540C 3545A 3550B 3562	3620B 3630C 3640A 3660
Organophosphates		8270D 2	8141B	8321B	3510C 3520C 3535A	3540C 3545A 3550B	3620B
PAHs	4035 (1 ppm)	8270D	8100 8275A	8310	3510C 3520C	3540C 3545 3550B 3561	3610B 3630 3640A 3650B
PCBs	4020 (5 ppm) 9078 (2 ppm)	8270D 2	8082A 8275A		3510C 3520C 3535A	3540C 3545A 3550B 3562	3620B 3630C 3640A 3660 3665A
Phenolics	4010A (0.5 ppm)	8270D	8041		3510C 3520C	3540C 3545 3550B	3630 3640A 3650B 8041
Phthalates		8270D	8061A		3510C 3520C 3535A	3540C 3545 3550B	3610B 3620B 3640A
Semi-Volatile Organics		8270D			3510C 3520C 3535A	3540C 3545A 3550B	3640A 3650B 3660
Total Organic Halides (TOX)			9020B 9022		9020B 9022		
Total Petroleum Hydrocarbons	4030 (5 ppm) 9074		8015B				
Volatile Organics		8260B	8015B 8021B		5030B — 5032	5021 5031 5032 5035	

Sources

All method numbers refer to EPA SW-846, Update III, with changes as proposed in Update IV.

Options shown are generally for chemical classes; more detailed information may be available for specific compounds

GC/MS methods allow for scanning a broad range of volatile and semi-volatile compounds, but suffer from interference and higher detection limits.

Specific determination methods and HPLC methods allow for more precise determinations of specific compounds of interest.

- 1 Series 4000 are immunoassays and are for specific compounds within these classes (i.e., 2,4-D, TNT, RDX, and PCP). Soil detection limits are in parentheses.
- 2 This is not a method of choice, but rather a confirmatory method.



Screening Quick Reference Tables

These tables were developed for screening purposes only; they do not represent official NOAA policy and do not constitute criteria or clean-up levels. All attempts have been made to ensure accuracy; however, NOAA is not liable for errors. Values are subject to changes as new data become available.

Because trace elements are naturally occurring compounds, concentrations reflective of non-anthropogenically impacted, or "background," are provided in addition to toxicological benchmarks. For screening, trace element levels may be compared to the geometric mean (and range) observed in natural soils in the U.S. Further comparisons to regional values is encouraged.

Promulgated criteria or standards for sediments or soils are generally not available in the U.S. For screening purposes, contaminant levels in solids (sediment or soil) may be compared to benchmarks representative of different characterizations of ecological risk. They should *not* be applied without a reasonable understanding of their development, their performance, and their limitations.

The NOAA SQUIRTs include multiple sediment screening values to help portray a spectrum of concentrations which have been associated with various probabilities of adverse biological effects. This spectrum ranges from presumably nearly non-toxic to toxic levels. For instance, if all analytes screen below lower-threshold values (for example, TELs), this suggests, with a high degree of confidence, that a sample with these levels of contaminants has a low probability of being toxic, as tested through standard bioassays. Conversely, exceeding lower thresholds does *not* necessarily predict toxicity. Comparison to higher toxicity thresholds (for example, PELs) identifies compounds which are more probably present at elevated, toxic levels.

Sources of benchmarks for sediment were chosen primarily on the basis of representing a fairly unique approach for their derivation. A major exception is the "Consensus TEC/PEC" values: these values are simply averages of other existing benchmarks (mostly those appearing in the SQUIRT cards). The consensus TEC/PECs are provided here merely as a service.

For soil- and sediment-associated contaminants, dry weight concentrations are screened directly against published benchmarks. Some benchmarks are available only on a Total Organic Carbon (TOC) normalized basis, and are footnoted as such. Separate values are provided for either freshwater and estuarine or marine sediments.

For freshwater sediments, the Upper Effects Threshold (UET) was derived by NOAA as the lowest AET from a compilation of endpoint analogous to the

marine AET endpoints. The UETs for organic contaminants are generally listed for a sediment containing 1% TOC.

This version of the SQUIRT cards adds a section on the composition of PCBs. A characterization of Aroclors by their degree of chlorination and congener patterns may aid in *preliminary* exploration of source type. Definitive Aroclor assignment should only be conducted by a qualified chemist.

To express cumulative toxicity from mixtures of dioxins and furans, Toxic Equivalency Factors are included in this version of the SQUIRT cards. Absolute concentrations can be multiplied by the TEF potency factors and the products then summed to derive total toxicity.

Every effort has been made to ensure accuracy in these SQUIRT cards. However, NOAA is not liable for errors in original sources or revision of values. These screening values are subject to change as new data become available. The SQUIRT cards may be freely reproduced and distributed, if they are distributed in their entirety, without modification, and properly credited to NOAA.

The SQUIRT cards should be cited as:

"Buchman, M. F., 2008. NOAA Screening Quick Reference Tables, NOAA OR&R Report 08-1, Seattle WA, Office of Response and Restoration Division, National Oceanic and Atmospheric Administration, 34 pages."

ATTACHMENT C

HEALTH AND SAFETY PLAN (HASP)

Project Name: Avery Landing Site Engineering Evaluation **Project #:** 073-93312-02

The Site is located along State Highway 5 about 0.75

Location of Project mile west of the town of Avery, Idaho **Date prepared:** 9/26/08, Rev 1/23/09

Site Description: This Engineering Evaluation will collect, develop, and evaluate sufficient information regarding the Site to recommend an appropriate removal action. Field activities will include:

- A characterization of the nature, extent, and potential sources of contamination at the Site
- An assessment of the groundwater and surface water impacts from the Site contamination
- An evaluation of the potential routes of exposure and risks to human and ecological receptors associated with contamination at the site

This section provides a description of Golder's proposed field investigations for better understanding the nature and extent of COPCs and potential Site risks. The HASP information for field investigations specific for the Treatability Study, Biological Assessment, and Cultural Resources will be addressed in addendums to this HASP.

- Additional Monitoring Well Installation
- Groundwater Hydraulic Gradient Investigation
- Groundwater Sampling
- Groundwater Pump Tests
- Near Shore Floating LNAPL and Surface Water Sampling

Project Manager: Douglas Morell *signature* **Date:** _____

Office Health & Safety

Coordinator Jane Mills *Signature* **Date:** _____

EMERGENCY ACTION PLAN

Emergency Contact & Services

<i>Title</i>	<i>Name</i>	<i>Contact #'s</i>
Site Safety Officer	TBD	(208) 755-3002
First Aid/CPR	TBD	(208) 755-3002
Project Manager	Douglas Morell	(425)351-7451
Office H&S Coordinator	Jane Mills	(206)295-7002
Client Contact		

<i>Title</i>	<i>Name</i>	<i>Contact #'s</i>
Hospital	Benewah Community Hospital	(208) 245-5551
Fire Dept.	Fire Departments & Districts Wallace Idaho 83873	208-752-1101
Ambulance		
Golder Corporate Safety Officer	Charlie Haury	904-607-6057 cell

How to Contact First Aid

1. Method of Communication: 911 Location of First Aid: 1st Aid kit will be maintained in the Golder project vehicle
2. Channel or phone number to be used N/A
3. Name of person(s) providing First Aid Golder on-site staff

Nearest Telephone if outside assistance is required: Residential properties located adjacent to the west of the site.

Fire / Explosion or other Emergencies Requiring Evacuation:

In the event of a fire or explosion, if the situation can be readily controlled with available resources without jeopardizing your health and safety or the health and safety of the public, or other site personnel, take immediate action to do so, otherwise:

1. Notify emergency personnel by calling 911
2. If possible, isolate the fire to prevent spreading.
3. Evacuate the area.
4. Assemble at Muster Station
5. Perform head count to ensure complete evacuation
6. Inform Emergency Personnel of any missing team members

Muster Station Location: On the road along
Highway 5

Golder personnel and all subcontractors will have a fire extinguisher inside of their respective field vehicles at all times while working onsite.

On Site Injury or Illness:

In the event of an injury requiring more than minor first aid, or any employee reporting symptom(s) of illness, or exposure to hazardous substances, immediately take the victim to:

Benewah Community Hospital • 229 South 7th Street • St. Maries, ID 83861 • (208) 245-5551

Benewah Community Hospital's Emergency Room is fully physician staffed, 24 hours a day, 7 days a week, with medical services available to handle a full range of serious injuries and illnesses. Board Certified emergency physicians and nurses, specially trained in critical care and emergency life saving with Advanced Life Support training in trauma, cardiac and pediatrics, staff our ER. Other physicians, well-trained nurses, and technologists, round out the ER team. If, after initial examination and stabilization, it is determined to be in the best interest of the patient, the hospital's life flight partner, Med Star, transports patients via helicopter to one of three major trauma hospitals within a 60 mile radius.

The Benewah hospital is located 47 miles and approximately 1 hour drive west of the site.

Driving directions to Benewah Community Hospital:

1. Turn **left** at **NFD 50 Rd/St Joe River Rd** (44 miles)
2. Turn **left** at **ID-3**
3. Continue on **S 3rd St**
4. Turn **right** at **W Jefferson Ave**
5. Turn **right** at **S 7th St**

PRE – DEPARTURE

IMPORTANT THINGS TO CHECK & REMEMBER

1. Look at the bottom of this page, and ensure that your Project Manager and Office Health & Safety Coordinator have approved this HASP.
2. Ensure that your Project Manager has discussed in detail this HASP, gone through the Hazard Assessment with you and explained the hazards associated with the work that you will be performing.
3. Ensure that you have all the required PPE and are trained in the areas which are indicated in this HASP.
4. Familiarize yourself with the Emergency Action Plan for the site prior to site arrival.
5. Check the weather in the immediate area of the project site to ensure that the current weather conditions do not create additional hazards that have not been evaluated.
6. Inquire about cell phone coverage (satellite phones may be the ONLY option in some locations) and physically test all of your means of communication to ensure that they function, and you are familiar with the controls.
7. If you are going to a site where activities are in progress, do not begin work until you have been given an orientation from the Site Safety Officer and have reviewed the site's Health & Safety Manual.
8. **You have the right to refuse any work that you feel is unsafe, or that you are not trained to do. Please discuss your concerns immediately with the project manager and office HSC.**

FIELDWORK HEALTH & SAFETY PLAN

<u>Project Personnel</u>							
Team Member	Function	Cell Ph. #	Other cont. #	Allergies	Emergency Contact		Init.*
					Name	Phone #	
**	**	**	**	**	**	**	**
	Contact Person			N/A	N/A	N/A	N/A

***All Golder Project Personnel must initial in this column beside their name to indicate that they have read & understood the project Health & Safety Plan**

**** Specific Golder Project Personnel information will be added prior to the initiation of on-site project activities.**

Special Instructions

1.	Must determine additional H&S requirements from Site Personnel prior to starting work.
2.	<i>[Information to be added as identified]</i>
3.	
4.	
5.	

HAZARD ASSESSMENT

Date: 9/26/08
Rev 1/23/09

Assessment Performed By: Jane Mills/Douglas Morell

Location: Avery, Idaho

Description Of Site : The site is a former railroad maintenance yard.

Work To Be Done: Please review detail below.

Excavations for Soil Bulk Sample Acquisitions

The soil investigation will focus on evaluation of the soil in 3 to 4 locations across the Site. The investigation will be conducted with an excavator removing soils to a depth of approximately 8' to 15' below ground surface. Golder will collect soil samples from the excavator bucket as they are retrieved by the excavating equipment. At no time will any Golder employee or subcontractor employee enter the excavation. Each excavation location will be re-filled once sampling is complete, and the excavation soils will be compacted with the excavator bucket.

Additional Monitoring Well Installation

The groundwater investigation will focus on the groundwater directly beneath the Site. A number of monitoring wells installed by EPA and Potlatch currently exist on the Site. During the investigation, one additional monitoring well (designated GA-1) will be installed between the St. Joe River and the existing monitoring well HC-1R. After monitoring well GA-1 installation is complete, the well will be surveyed for x, y, and z coordinates using the same datum used for the other existing Site wells.

Groundwater Hydraulic Gradient Investigation

To better understand the flow of groundwater at the Site, monitoring wells will be monitored for groundwater levels (elevations) changes. The water levels in the wells will be monitored monthly, depending on weather conditions for access. A temporary staging station will be installed near the Site on the St. Joe River for measurements of river water levels. The up-stream bridge at Avery, Idaho may be used to establish a temporary river stage station if one does not exist in the area.

Groundwater Sampling

Two groundwater sampling events are proposed confirm analytical results. Each well will be inspected for the presence of a floating LNAPL and where present its thickness will be estimated. A sample of the floating LNAPL will be obtained from two monitoring wells, MW-11 and HC-4, which historically had significant thickness of the floating LNAPL. The LNAPL from these wells will be analyzed for the list of COPCs.

The groundwater samples will be obtained in a manner that will reduce entrained settleable soils particles and LNAPL carry-down. Two samples will be obtained from each well for metal analyses with one being inline filtered prior to preservation. The results will be used to evaluate whether additional wells are needed in a Phase II investigation. Wells will be surveyed and water-level elevations measured on the same day and prior to any groundwater purging or sampling.

Groundwater Pump Tests

Short-term slug tests will be performed on 4 selected monitoring wells. The selection of wells for slug-testing will be based on well installation documentation, field inspections, and aerial representativeness.

Near Shore Floating LNAPL and Surface Water Sampling

The St. Joe River water will be sampled along the river embankment to assess discharges and impacts from the Site. Two sampling events will be conducted that coincide with the two groundwater sampling events. River station RS-1 will represent up-river background for comparison to river stations RS-2 through RS-5. At each river station, samples of any floating product (except at RS-1) and surface water will be obtained. The samples will be analyzed for the list of COPCs.

Hazard	Notes	Necessary Controls	Standard Work Procedure Attached (see appendix)
<u>Travel to site:</u>			
Aircraft	<input type="checkbox"/>		
Helicopter	<input type="checkbox"/>		
Boat	<input type="checkbox"/>		<input type="checkbox"/> Working on or over water
Public or Private Roads/Driving	<input checked="" type="checkbox"/> Golder personnel will drive to and from the project site.	Defensive driving methods will be employed at all times when operating motor vehicles	<input checked="" type="checkbox"/> Motor Vehicles and Driving on Company Business
Other	<input type="checkbox"/>		
<u>Site Terrain</u>			
Shafts/Trenches/Slopes	<input type="checkbox"/>		<input type="checkbox"/> Trenching and Shoring
Overhead Hazards	<input type="checkbox"/>		<input type="checkbox"/> Overhead Hazards
Water Hazards	<input checked="" type="checkbox"/> Some surface water and sediment sampling will be conducted along the St. Joe river embankment	At no time will the Golder employee collecting the sample enter the water. At all times employees should be aware of the condition of the ground surface at the edge of the water. During near shore sampling activities appropriate personal flotation devices must be worn.	<input checked="" type="checkbox"/> Working on or over water
Underground Utilities	<input checked="" type="checkbox"/> Utility locate investigations will be conducted prior to drilling the new groundwater monitoring well.	No drilling will be conducted on the site until completion of the utility locate can be confirmed, either by observing markings on the ground indicating locations of buried utilities, or direct confirmation with the utility locate. Public right-of-way will be located using a public locating service, and all other areas will be located using a private locating service and a geophysical investigation.	<input checked="" type="checkbox"/> Underground Utilities
Confined Space(s)	<input type="checkbox"/> An additional Plan is required for this hazard- See Appendix		<input type="checkbox"/> Work in Confined Spaces
Slip, Trip / Fall Hazards	<input type="checkbox"/>		<input type="checkbox"/> Slips, Trips and Falls
Other	<input type="checkbox"/>		
<u>Work at Heights</u>			
Ladders/ Scaffolds	<input type="checkbox"/>		
Work Platforms	<input type="checkbox"/>		
Shafts	<input type="checkbox"/>		
<u>General Work Environment</u>			
Heat Stress	<input type="checkbox"/>		<input type="checkbox"/> Heat Stress
Cold Stress	<input checked="" type="checkbox"/> Work may be conducted during the Fall and Winter when temperatures may dip below 50 degrees F	Golder employees will be prepared at all times with sufficient warm clothing and a change of clothes in the event that their clothing becomes wet during a work shift.	<input checked="" type="checkbox"/> Cold Stress
Lightening/Tornado/Hurricane/Severe Weather	<input type="checkbox"/>		<input type="checkbox"/> Inclement Weather
Remote Site	<input checked="" type="checkbox"/> The site is adjacent to a transitory camping ground that does not necessarily have permanent residents. The closest towns are St. Marie's and Wallace, both over one hour away from the site.	Golder personnel will make contact with the Project Manager or Director daily at prescribed times as defined in the Project Site Contact Form included in this HASP.	<input type="checkbox"/> Remote Isolated Surveys
Noise Levels	<input checked="" type="checkbox"/> When mechanical equipment is operating (excavator and drill rig)		<input checked="" type="checkbox"/> Hearing Protection
Wild Animal Habitat	<input type="checkbox"/>		<input type="checkbox"/> Biological Exposure Risks
Housekeeping	<input type="checkbox"/>		<input type="checkbox"/> Housekeeping
Poor Lighting	<input type="checkbox"/>		
Extended work hours	<input type="checkbox"/>		
Working Alone	<input type="checkbox"/>		
Proximity to Traffic	<input type="checkbox"/>		<input type="checkbox"/> Motor Vehicles and Driving on Company

				Business
Other	<input type="checkbox"/>			
<u>Mechanical Process:</u> Unstable Structures	<input type="checkbox"/>			
Moving Parts/Heavy Equipment	<input type="checkbox"/>			<input type="checkbox"/> Working Around Heavy Equipment
Drilling / Pile Driving	<input checked="" type="checkbox"/>	Drilling will be conducted during parts of this project	Golder employees will follow the SWP.	<input checked="" type="checkbox"/> Drilling
Excavation	<input checked="" type="checkbox"/>	Excavation will be conducted during parts of this project	Golder employees will follow the SWP.	<input checked="" type="checkbox"/> Trenching and Shoring

Hazard	Notes	Necessary Controls	Standard Work Procedure Attached (see appendix)
<u>Chemical & Biological Contaminants</u>			
Dust	<input type="checkbox"/>		<input type="checkbox"/> Respiratory Protection
Carcinogens	<input type="checkbox"/>		<input type="checkbox"/> Chemical Exposure Risks** ** fill out table below <input type="checkbox"/> Respiratory Protection
Radioactive Particles	<input type="checkbox"/>		
Oxygen deficient	<input type="checkbox"/>		
Asbestos	<input type="checkbox"/>		<input type="checkbox"/> Respiratory Protection
Explosive atmosphere	<input type="checkbox"/>		
Mold	<input type="checkbox"/>		
Insects (e.g., ticks)	<input checked="" type="checkbox"/> During the summer months mosquitoes and ticks may be a biological hazard at the site.	Insect repellent and proper tick protection measures should be employed during the summer months.	<input checked="" type="checkbox"/> Biological Exposure Risks
Chemical contaminants	<input checked="" type="checkbox"/> The following is a list of chemicals of potential concern at the Site: • Diesel and heavy oil • Napthalenes • PAHs (including carcinogenic PAHs) • Metals in the Ground Water		<input type="checkbox"/> Chemical Exposure Risks** ** fill out table below <input type="checkbox"/> Respiratory Protection
Other contaminants	<input type="checkbox"/>		
Fire	<input type="checkbox"/>		
Chemical Storage	<input type="checkbox"/>		
Compressed Gas	<input type="checkbox"/>		
Explosives (storage)	<input type="checkbox"/>		
Explosives (transport)	<input type="checkbox"/>		
Nuclear Densometer	<input type="checkbox"/>		Must have office Radiation Safety Plan attached and at the job Site
Other	<input type="checkbox"/>		
<u>Other Site Issues</u>			
Landfill CQA	<input type="checkbox"/>		<input type="checkbox"/> Landfill CQA
Landfill Gas	<input type="checkbox"/>		<input type="checkbox"/> Landfill Gas Sampling
Hand and Power Tools	<input type="checkbox"/>		<input type="checkbox"/> Hand and Portable Power Tools
GOLDER Hired Contractors	<input type="checkbox"/>		
Possible exposure to violence from general public	<input type="checkbox"/>		
Cellular Phone Usage	<input checked="" type="checkbox"/> The site may have limited cell phone coverage.	Precautions should be made to ensure that communications with the home office and the project manager occur daily.	<input checked="" type="checkbox"/> Cellular Telephone Use
Projectiles / Sharps	<input type="checkbox"/>		
	<input type="checkbox"/>		
	<input type="checkbox"/>		
	<input type="checkbox"/>		
	<input type="checkbox"/>		

OSHA CONTAMINANT EXPOSURE INFORMATION					
Substance CAS No.	Ionization Potential eV	OSHA TWA Exposure Limit	OSHA STEL / Ceiling Limits	IDLH Level	Target Organs
Acenaphthene CAS No. 83-32-9	N.P	benzene soluble fraction 0.2 mg/m ³ (coal tar pitches)	None Listed	None Listed	None Listed
Benzo (a) pyrene CAS No. 50-32-8 (Surrogate for all PAHs)	N.P	benzene soluble fraction 0.2 mg/m ³ (coal tar pitches)	None Listed	None Listed	None Listed
Ethylbenzene CAS No. 100-41-4 (Surrogate for diesel and heavy oil)	8.76 eV	100 ppm (435 mg/m ³)	None Listed NIOSH STEL 125 ppm	800 ppm (10% LEL)	Eyes, skin, respiratory system, central nervous system
Naphthalene CAS No. 91-20-3	8.12 eV	10 ppm	None Listed NIOSH 15 ppm	250 ppm	Eyes, skin, central nervous system, blood, liver.
Toluene CAS No. 108-88-3 (Surrogate for diesel and heavy oil)	8.82 eV	OSHA 200 ppm 100 ppm* NIOSH REL 100 ppm	OSHA 300 ppm NIOSH STEL 150 ppm	500 ppm	Eyes, skin, respiratory system, central nervous system, liver, kidneys.
o, m, p, Xylenes (o) CAS No. 95-47-6 (m) CAS No. 108-38-3 (p) CAS No. 106-42-3 (Surrogate for diesel and heavy oil)	8.44-8.56 eV	100 ppm	150 ppm	900 ppm	Eyes, skin, respiratory system, central nervous system, GI tract, blood, liver, kidneys.

Signature of Project Manager: _____ Date: ____ / ____ / ____

This signature indicates that the above project manager is aware of the potential hazards at this site, and will communicate these hazards, and appropriate controls to Golder staff prior to their deployment on site.

PERSONAL SAFETY EQUIPMENT & TRAINING REQUIREMENT SUMMARY

<u>Personal Protective Equipment (PPE) & Additional Equipment Required</u>		
PPP/ Equipment	Required?	Notes:
Hard Hat	Std/D	During Sampling Activities
Eye Protection	Std/D	
Steel Toe Boots	Std/D	
Hearing Protection	<input checked="" type="checkbox"/>	Must be worn whenever mechanical equipment is operating.
Hi-Vis Vest	<input checked="" type="checkbox"/>	
Face Protection	<input type="checkbox"/>	
TYVEK Suit	<input type="checkbox"/>	
Gloves	<input checked="" type="checkbox"/>	Must be worn whenever sample collection is conducted.
Fall Protection	<input type="checkbox"/>	
Life Preserver (PFD)	<input checked="" type="checkbox"/>	Must be worn when working along the St. Joe River.
Cold Weather Gear	<input type="checkbox"/>	
Self Rescuer	<input type="checkbox"/>	
Dosimeter(Badge)	<input type="checkbox"/>	
Headlamp	<input type="checkbox"/>	
Boots (other)	<input type="checkbox"/>	
Bear Spray	<input type="checkbox"/>	
Air Quality Monitor	<input type="checkbox"/>	
Fire Extinguisher	<input checked="" type="checkbox"/>	Stored in vehicle.
First Aid Supplies	<input checked="" type="checkbox"/>	
Whistle/ Air horn	<input type="checkbox"/>	
Washing Facilities	<input type="checkbox"/>	
Drinking Water	<input checked="" type="checkbox"/>	
Additional Communication	<input type="checkbox"/>	
Wheel Chocks	<input type="checkbox"/>	
	<input type="checkbox"/>	

<u>Training Requirements</u>		
Training Program	Required?	Staff Requiring
Golder Health & Safety Orientation	X	All Golder Field Staff
OSHA 10-hr Construction Safety	X	All Golder Field Staff
First Aid/CPR	X	All Golder Field Staff
OSHA HAZWOPER	<input checked="" type="checkbox"/>	
MSHA Part 48 - Surface	<input type="checkbox"/>	
MSHA Part 48 - Underground	<input type="checkbox"/>	
MSHA Part 46 - Surface	<input type="checkbox"/>	
Confined Space Entry	<input type="checkbox"/>	
Respirator Fit Testing	<input type="checkbox"/>	
Industrial First Aid	<input type="checkbox"/>	
Transport. Danger. Goods	<input type="checkbox"/>	
Emergency Procedures	<input type="checkbox"/>	
Boat Safety	<input type="checkbox"/>	
Self Rescuer Use	<input type="checkbox"/>	
Helicopter Safety	<input type="checkbox"/>	
Fall Protection Training	<input type="checkbox"/>	
Rescue Training	<input type="checkbox"/>	
	<input type="checkbox"/>	
	<input type="checkbox"/>	
	<input type="checkbox"/>	
	<input type="checkbox"/>	

CHANGES TO THE FIELD HEALTH & SAFETY PLAN

If the conditions / hazards in the field are significantly different from those anticipated / assessed in the Potential Hazard Assessment, the Project Manager (PM) must be informed immediately. At this point the PM will decide on the appropriate course of action, and give you verbal authorization to enter this information into the **special instructions** section of this HASP. This may include a temporary work stoppage.

Action Levels:

Site workers must notify the site health and safety coordinator immediately in the event of any injury, or if signs or symptoms of overexposure to hazardous substances are exhibited. Specific hazardous substances expected at the site and action levels are identified and listed below.

Monitoring Instrument	Monitoring Frequency	Action Level/Criteria	Specific Action
PID	Continuously during well drilling activities	If the PID reading is 10 ppm (in breathing zone) ¹	Cease work and evacuate area. Upgrade to level C for emergency stabilization/ demobilization purposes only. Evaluate if mechanical ventilation is feasible. Contact PM and HSC for further options.

¹ This should be established on each site based on the contaminants present and should be set at one-half of the lowest published standard. Be careful that the PID will measure the contaminant and compensate for how well the contaminant is measured (see manufacturer data).

In summary, the following is a list of COPCs for the Site:

- Diesel and heavy oil
- Naphthalenes
- PAHs (including carcinogenic PAHs)
- Metals in the Ground Water

☒ Chemical Exposure Information included in this HASP

PROJECT SITE CONTACT FORM
(COPY MUST BE GIVEN TO THE PROJECT MANAGER OR DIRECTOR)

Project Title: Avery Landing Site Engineering Evaluation Project Number: 073-93312-02

Site Name: Potlach Avery Landing

Street Address: The Site is located along State Highway 5 about 0.75 mile west of the town of Avery, Idaho.

Employee Name: [TBD] Res. Phone: [TBD]

Pager Number: [TBD] Cell Phone: [TBD]

Project Manager: [TBD] Res. Phone: [TBD]

Site H&S Contact: [TBD]

Phone No. of H&S Contact: [TBD]

REMOTE SITES CONTACT

Departure Date: [TBD] Expected Return: [TBD]

Lodging: [TBD] Phone No: [TBD]

Emergency Notification Procedures for Key Contact Person

Within 4 hours of missed check-in time:

- Try to contact employee by radio or phone, as appropriate
- Check employee's hotel
- Call client site and request client try to locate employee
- Check with other Golder employees in the area

After a maximum of 4 hours (less time may be appropriate based on weather conditions or other factors) of failed contact:

Notify the following that the employee is "overdue".

- Office Manager
- Search & Rescue
- Client
- Other Golder employees in the area

ON SITE SAFETY BRIEFING TRACKING FORM

Meeting Type- Site Orientation or Tailgate Talk	Meeting Attendee	Initials*	Date	Topics Discussed / Concerns Brought Forward
To be completed during the project.				

*Please ensure that all workers (including other contractors) attending the safety meeting, initial the column beside their name *

ATTACHMENT D

BIOLOGICAL ASSESSMENT WORK PLAN



TECHNICAL MEMORANDUM

TO: Potlatch Forest Holdings Inc. Terry Cundy
FR: Douglas Morell and Donna DeFrancesco,
Golder Associates
RE: **DRAFT BIOLOGICAL ASSESSMENT WORK PLAN FOR AVERY LANDING SITE**

DATE: February 20, 2009
OUR REF: 073-93312-02.002

1.0 INTRODUCTION

The following information provides a description of the work plan anticipated to be conducted to develop a Biological Assessment (BA) for Potlatch's Avery Landing Site. Final methodologies and Project Actions to be considered in the Biological Assessment will be determined based on the EPA selected removal action from the Engineering Evaluation/Cost Analysis (EE/CA) Report.

Section 7 of the Endangered Species Act (ESA) requires preparation of a BA for any major construction project with a federal nexus. The purpose of a BA is to evaluate whether the potential effects of a proposed project will adversely affect threatened and endangered species occurring in the project area. The BA will also determine if the project will jeopardize the continued existence of candidate species or species proposed for listing under the ESA and if it will adversely affect designated or proposed critical habitats that are likely to occur in the vicinity of the project.

Development of the BA will use the "best available scientific and commercial information" (USFWS, NOAA Fisheries 1994). This information will be used to help analyze project impacts and is the basis for the effect determination. Ultimately, this information will be evaluated by the Services for acceptance.

The BA will provide a description of the proposed action (project), a summary of species biology and distribution, and a description of the environmental baseline for the project including the status and distribution of these species in the project area based on current knowledge and information. The BA will provide an assessment of the potential effects of the project on listed species and a determination about any potential adverse effects based on this information. The BA will be based largely on available information, however, some primary data may be collected from the site through habitat mapping or plant, fish, wildlife surveys depending on the amount of existing information available and the listed species within and surrounding the project area.

2.0 METHODS

The BA report will be prepared following the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) (1998) *Final ESA Consultation Handbook: Procedures for Conducting Section 7 Consultations and Conferences*. The BA will provide a summary of the available information regarding listed, proposed, and candidate species in the area as well as critical habitat and a thorough effects analysis of the proposed project on the species and habitat. A letter

from the USFWS dated January 16, 2008 to the EPA provided a threatened, endangered, proposed and candidate species list for the Avery Landing Site. At the time of that letter, Gray wolf (*Canis lupus*) and Bull trout (*Salvelinus confluentus*) were identified as the listed species in and near the project area. No candidate species were identified. Bull trout critical habitat was also identified in the project area.

Updated species lists will be obtained prior to the preparation of the BA. Species and habitat information sources may include published literature (including internet resources); a search of the Idaho Conservation Data Center Database (CNDB) maintained by the Idaho Department of Fish and Game; data available from the USFWS; and communication and interviews with resource experts and agency personnel. The request area for species information may include all of the 1:24,000 USGS quad boundaries that intersected a two mile buffer of the project area.

Proposed species are those for which the USFWS has formally proposed to list as threatened or endangered. Once proposed, there is typically a status review period (often 12 months) where the USFWS reviews all existing information, data, and threats to the species and makes a listing decision. Species proposed for listing receive protection under the ESA in that proposed projects may not jeopardize the continued existence of these species. The USFWS maintains a list of candidate species for listing as threatened or endangered.

Candidate species are those for which the USFWS has sufficient information on their status and threats to propose them as endangered or threatened, but for which proposed listing is precluded by other higher priority species or actions (USFWS 2000). While candidate species receive no protection under the ESA, the USFWS encourages actions that conserve these species. Critical habitat for threatened or endangered species is defined by the Endangered Species Act as the specific area(s) within the geographical range of a species where physical or biological features are found that are essential to the conservation of the species and which may require special management consideration or protection. Critical habitat is specific geographic area(s) designated by the USFWS for a particular species. Under the ESA, it is unlawful to adversely modify designated critical habitat.

A site review of the project area including habitat types present will be performed prior to the preparation of the BA. Descriptions of the project area and habitat will be based on site visits, examination of aerial photographs and topographic maps, and results of any ecological baseline studies conducted for the project. The nature of any ecological baseline studies (i.e spawning survey, redd counts, fish habitat, etc) will be determined based on the EPA selected removal action.

Descriptions of potential habitat, natural history, and behaviors will be based mainly on published literature and communications with resource experts. The occurrence and status of listed species in and near the project area will be based on the available information, communication with agency personnel, and data collected from the project area. Any additional needs for primary data collection (field studies or field verifications) will be determined based on the amount of existing information available and the Project Actions.

3.0 EFFECTS DETERMINATION

The BA will provide information for all listed species focusing on, but will not be limited to:

- establishing the current status, use, and behavior of the species in the project area
- establishing the current distribution of important habitat in the project area for the species

- determining the direct, indirect, and cumulative effects (as defined by the ESA) on the species within the project area
- determining the likelihood of the project adversely affecting the species
- identifying conservation measures (mitigation) that may be implemented to avoid and minimize adverse impacts to the species
- determining the expected status of the species within the project area after project construction

The BA will include a matrix that lists species, status, habitat, presence of habitat on site, and likelihood of occurrence at Avery Landing site. The BA will evaluate potential effects of the proposed project, including: direct, indirect, and cumulative effects. Potential effects associated with major construction projects on threatened and endangered species include both direct and indirect effects. Direct effects are results of the proposed action and would include effects such as loss of habitat and mortality of individuals. Indirect effects are those caused by the proposed action that are reasonably certain to occur and may include effects such as disturbance and/or displacement of individuals, and change in habitat suitability or habitat degradation. Effects may be temporary (short-term), for example the life of the construction, or long-term, depending on the nature of the project actions. Also, effects may be cumulative, arising from the total impact of development, management, and use of the surrounding land.

Prior to initiation of any construction, the species list will be confirmed and the BA may be revised (or amended) if: (1) the scope of work changes significantly so as to create potential effects to listed species not previously considered; (2) new information or research reveals effects of the proposed project may impact listed species in a manner not considered in this BA; or (3) a new species is listed or critical habitat designated that may be affected by the project.

4.0 REFERENCES

U. S. Fish and Wildlife Service/National Marine Fisheries Service. 1994. Endangered and Threatened Wildlife and Plants: Notice of Interagency Cooperative Policy for Peer Review in Endangered Species Act Activities, Washington , D. C.

U. S. Fish and Wildlife Service. 2000. The Endangered Species Act and Candidate Species. U. S. Fish and Wildlife Service, Division of Endangered Species, Arlington, Virginia

U.S. Fish and Wildlife Service. January 16, 2008. Letter to EPA concerning Species List for Former Railroad Maintenance and Refueling Facility. Signed Suzanne Ardet. USFWS.

U.S. Fish and Wildlife Service and National Marine Fisheries Service. 1998. *Final ESA Consultation Handbook: Procedures for Conducting Section 7 Consultations and Conferences*. U. S. Fish and Wildlife Service, Division of Endangered Species, Arlington, Virginia

ATTACHMENT E

CULTURAL RESOURCE WORK PLAN



Golder Associates Inc.

18300 NE Union Hill Road, Suite 200
Redmond, Washington 98052-3333
Telephone (425) 883-0777
Fax (425) 882-5498
www.golder.com



TECHNICAL MEMORANDUM

TO: Potlatch Land and Lumber, LLC **DATE:** February 20, 2009
FR: Tom Hoffert and Douglas Morell **OUR REF:** 073-93312-02.002
RE: DRAFT CULTURAL RESOURCES WORK PLAN FOR THE AVERY LANDING SITE, AVERY, IDAHO

A number of steps will be taken to complete the pre-field assessment of the cultural resources that may be affected by the proposed project at the Avery Landing Site in Avery, Idaho. The first step will be to conduct a Class I inventory. Depending on the results of a Class I Inventory, the State Historic Preservation Office (SHPO) of Idaho may require a Class II or Class III Inventory to be conducted.

1.0 CLASS I INVENTORY

A Class I inventory will be initiated and conducted prior to any ground breaking activities. A Class I inventory will consist of an overview of Idaho SHPO files of all previous archaeological inventories and recorded sites located in the area of potential effect (APE) of the proposed project.

The Class I inventory will consist of:

A site file search:

Per the accepted standard within the archaeological discipline, the search will be conducted by an Idaho permitted archaeologist and will encompass all lands within one mile of the Project. The search will indicate whether previous archaeological inventories have occurred within the area of potential effect (APE) and what types of sites may be expected in the region. The number, type and significance of any sites recorded during previous inventories within the APE will also be shown. Any cultural resources evaluation or inventories conducted by the U.S. Environmental Protection Agency (EPA) or their consultants for investigation activities will be obtained from SHPO during the Class I Inventory.

Obtaining/reviewing previous documentation and records:

If sites are present within the requested search parameters, the site forms will be obtained from the Idaho SHPO, which is charged with maintaining the permanent records for Idaho. Past project reports will also be acquired. Historic maps will also be reviewed in order to determine the presence of significant historic features such as homesteads or transportation routes. A nominal fee is required by the SHPO for these services.

Tribal consultation:

The Project area is within the traditional territory of the Coeur d'Alene Tribe and as such the Tribe will be consulted regarding their knowledge of any past traditional land use in the area or to

determine if the Tribe has any concerns with the proposed undertaking at the Site. A representative of the Tribe will also be afforded the opportunity to partake in the Class III inventory, if indeed a Class III inventory is required by Idaho SHPO.

2.0 CLASS II OR CLASS III INVENTORY:

Depending upon the results of the Class I inventory, the Idaho SHPO will then decide whether or not the APE requires a subsequent Class II or Class III inventory. The SHPO may also decide that no additional work is required. If the pre-field Class I inventory shows that all or portions of the APE have been subject to previous archaeological inventory, and that no significant sites or features are in conflict with the proposed development, then no further work is expected to be required in the for the Avery Landing Site.

A Class II inventory is usually used only as a methodology in large scale projects for locating areas with good or better cultural resources potential which would then require investigation at the Class III level.

A Class III inventory is a systematic, detailed field inspection done by a professional historian, architectural historian, archaeologist, and/or other appropriate specialists. This type of inventory is usually required to formulate a preliminary determination of the significance of resources and their eligibility for listing in the National Register of Historic Places (NRHP). It is preceded by an adequate literature search (Class I), and, sometimes, by a reconnaissance effort (Class II).

If it is required that a Class III inventory be conducted in order to meet the requirements of Section 106 of the National Historic Preservation Act 36 CFR Part 800 (as amended), a permit will be obtained from the Idaho SHPO prior to any work being conducted.

The Class III inventory will consist of a two person crew of archaeologists conducting transects spaced no more than 30 meters apart across the entire surface soils of the Site. All artifacts and features whether historic or prehistoric will be recorded and their location documented using a hand held Global Positioning System (GPS) unit.

3.0 REPORTING

Once work is completed a report documenting the results of the Class I and Class III (if required) Inventory along with any relevant background research will be incorporated into a report. The report will then be submitted for concurrence by the Idaho SHPO.